



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

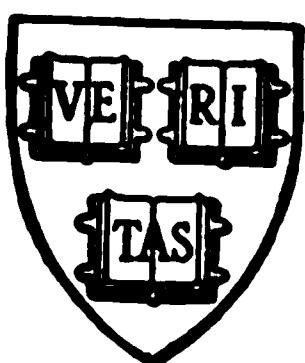
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



3 2044 011

✓ 608.26



**HARVARD
COLLEGE
LIBRARY**

**THE
NEW AMERICAN
PRACTICAL NAVIGATOR:**
**BEING AN
EPITOME OF NAVIGATION;
CONTAINING ALL THE TABLES NECESSARY TO BE USED WITH THE
NAUTICAL ALMANAC,
IN DETERMINING
THE LATITUDE, AND THE LONGITUDE
BY
LUNAR OBSERVATIONS:
AND
KEEPING A COMPLETE RECKONING AT SEA:
ILLUSTRATED BY
PROPER RULES AND EXAMPLES:
THE WHOLE EXEMPLIFIED IN A JOURNAL,
KEPT FROM BOSTON TO MADEIRA,
IN WHICH ALL THE RULES OF NAVIGATION ARE INTRODUCED.
ALSO,
THE DEMONSTRATION OF THE USUAL RULES OF TRIGONOMETRY:
PROBLEMS
IN MENSURATION, SURVEYING AND GAUGING:
DICTIONARY OF SEA-TERMS:
AND THE MANNER OF
PERFORMING THE MOST USEFUL EVOLUTIONS AT SEA.
WITH AN
APPENDIX,
CONTAINING
METHODS OF CALCULATING ECLIPSES OF THE SUN AND MOON, AND OCCULTATIONS OF THE
FIXED STARS: RULES FOR FINDING THE LONGITUDE OF A PLACE BY OBSERVATIONS
OF ECLIPSES OR OCCULTATIONS: AND A NEW METHOD FOR FINDING THE
LATITUDE BY TWO ALTITUDES.**

BY NATHANIEL BOWDITCH, LL. D.

*Petitioner of the Royal Societies of London, Edinburgh, and Dublin; of the American Philosophical Society,
held at Philadelphia: of the American Academy of Arts and Sciences; of the Connecticut Academy
of Arts and Sciences; of the Literary and Philosophical Society of New-York, &c.*

SIXTH STEREOTYPE EDITION.

NEW-YORK:

**PUBLISHED BY EDMUND M. BLUNT, PROPRIETOR,
AND AUTHOR OF THE AMERICAN COAST PILOT,
No. 202, WATER-STREET.**

John Gray & Co. Print.

1826.

✓
law 608.26
Aug. 1826.
**STANDARD WORKS,
PUBLISHED BY EDMUND M. BLUNT,**

Author of the American Coast Pilot, &c.

202

**WATER, CORNER OF FULTON STREET—NEW-YORK,
[OLD ESTABLISHED STAND.]
BOOKS.**

BOWDITCH'S PRACTICAL NAVIGATOR, 6th edition, stereotyped. *This work has been re-published in London, and has a decided preference to any extant.*

BLUNT'S AMERICAN COAST PILOT, 10th edition, greatly improved.

THE MERCHANT'S AND SHIP MASTERS ASSISTANT, comprehending all the necessary mercantile information for Merchants and Shipmasters. *[In this work all recent commercial regulations are introduced, and the most experienced will find something new.]*

THE EXPEDITIOUS MEASURER, containing a set of tables, which show at one view the solid contents of all kinds of packages and casks, according to their several lengths, breadths, and depths; also rules for determining the contents of all sorts of casks, in wine and beer measure. *A stereotype edition.*

NAUTICAL ALMANACS, from the year 1811 to 1828, both inclusive—to be continued annually. Explanation stereotyped, and English copy corrected.

Errors in the English copies of the Nautical Almanac.

In { 1826, Over Fifty errors
1827, Over Fifty errors
1828, Over Twenty errors } Corrected in BLUNT'S EDITIONS ONLY.

SEAMANSHIP and NAVAL TACTICS, Second Edition, with Plates.

WARD'S LUNAR TABLES, 2d. edition.

CHARTS:

A NEW CHART, extending from New-York to Havana, including Bahama Banks and Channels, improved by actual Surveys of the *Chesapeake Bay*, by order of the Navy Department, and of *Capes Hatteras, Look Out and Fear Shoals*, in conformity to an act of Congress of the United States, and conducted under the direction of J. D. ELLIOT, Esq. Capt. in the U. S. Navy, and by permission of Hon. SMITH THOMPSON, Secretary of the Navy, copied, and contains all the Surveys made on the Coast of *North Carolina* to the present time (1826.) This Chart has since been improved by a survey from Sandy Hook to Cape May, under direction of Capt. JONATHAN COLESWORTHY, and EDMUND BLUNT, hydrographer, in the sloop New Packet. It has also several PLANS of HARBOURS, from actual surveys.

_____ of the Mississippi River, extending to New Orleans, including Mobile, &c. with sailing directions, and Plan of Mobile, on a large scale, from actual survey, published in 1825.

_____ of Bahama Bank, from actual survey made in sloop Orbit, in 1820, with sailing directions, by the direction and at the expense of E. M. BLUNT, by E. C. WARD, U. S. Navy, and EDMUND BLUNT, hydrographer. [It is worthy of remark, that nineteen vessels were lost on the Bahama Bank the year previous to this survey, since which, accidents have rarely occurred, and the correctness of the Chart admits not a question, but has received the approbation of thousands, as being the most correct Chart of Bahama Bank extant.]

_____ from New-York to Nova Scotia, extending from latitude 38° N. to latitude 47° N. longitude 68° W. to longitude 74° W. including the whole of St. George's Bank, improved to August 1821, by government and other surveys.

_____ of the Atlantic or Western Ocean, improved to 1820, with an Analysis of the authorities upon which the dangers have been inserted on the Chart. The Tracks extend to the Equator, and are continued on the Chart of the South Atlantic Ocean.

_____ of the South Atlantic Ocean, containing more authentic information than any extant, part of which describes dangers lately discovered, with original Plans of Harbours and Views.

_____ of the North Coast of Brazil, showing the entrances and courses of the Rivers Para and Amazon.

_____ of the West Indies, on six sheets, which may be had separate.

_____ of River La Plate, according to late Surveys, with Sailing Directions on the Chart.
_____ of the Coast of Guayana.—of the Coast of Brazil.—of the Island of Bermudas, with Sailing Directions.—of Long-Island Sound, improved to 1825.—of the Coast of Labrador.—of Newfoundland.—of the Coast of Brazil, from Maranham to the river La Plate, &c. &c. the sailing Directions for which are in Blunt's American Coast Pilot.

PLAN of New-London Harbour, surveyed by CHARLES MORRIS, Esq. of the United States Navy, by order of Commodore RODGERS, and to him respectfully dedicated.

SOUTHERN DISTRICT OF NEW-YORK, ss.

BE IT REMEMBERED, That on the twenty-second day of June, A. D. 1826, in the fiftieth year of the Independence of the United States of America, Edmund M. Blunt, of the said district, hath deposited in this office the title of a book, the right whereof he claims as proprietor, in the words following, to wit:

"The New American Practical Navigator: being an Eplome of Navigation: containing all the Tables necessary to be used with the Nautical Almanac, in determining the Latitude, and the Longitude by Lunar Observations; and keeping a complete Reckoning at Sea; illustrated by proper Rules and Examples: the whole exemplified in a Journal, kept from Boston to Madeira, in which all the rules of Navigation are introduced. Also, the Demonstration of the usual Rules of Trigonometry; Problems in Mensuration, Surveying, and Gauging; Dictionary of Sea-Terms; and the manner of performing the most useful Evolutions at Sea. With an Appendix, containing Methods of calculating Eclipses of the Sun and Moon and Occultations of the Fixed Stars; Rules for finding the Longitude of a place by Observations of Eclipses or Occultations: and a new method for finding the latitude by two altitudes. By Nathaniel Bowditch, LL. D. Fellow of the Royal Societies of London, Edinburgh, and Dublin; of the American Philosophical Society, held at Philadelphia; of the American Academy of Arts and Sciences; of the Connecticut Academy of Arts and Sciences; of the Literary and Philosophical Society of New-York, &c. Sixth stereotype edition."

In conformity to the act of congress of the United States, entitled "An Act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the Authors and Proprietors of such copies, during the time therein mentioned." And also to an act, entitled "an act supplementary to an act, entitled an act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the times therein mentioned, and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

JAMES DILL.

Clerk of the Southern District of New-York.

PREFACE.



IN the preface to the first edition of this work, it was observed, that the object of the publication was to collect into one volume all the rules, examples and tables necessary for forming a complete system of *practical* navigation. To do this, those authors were consulted whose writings afforded the best materials for the purpose,* and such additions and improvements were introduced as were suggested by a close attention to the subject; and the accuracy of the tables accompanying the work was ensured by actually going through all the calculations necessary to a complete examination of them, making the last figure exact to the nearest unit. In performing this, above eight thousand errors were discovered and corrected in Moore's *Practical Navigator*, and above two thousand in the second edition of Maskelyne's *Requisite Tables*.† Almost all the errors in Maskelyne's collection were in the last decimal place, and in most cases would but little affect the result of any *nautical* calculation; but when it is considered that most of those tables are useful in *other* calculations, where great accuracy is required, it will not be deemed an unnecessary improvement to have corrected so great a number of small errors.

Several articles were added in the second edition, particularly the description and use of the circular instrument of reflection, methods of surveying harbours, new tables, &c. In the third and subsequent editions, several improvements have been made, particularly in the method of correcting the dead reckoning, and in the articles of surveying. An Appendix is given, containing methods of projecting and calculating eclipses of the moon and sun, and occultations of the fixed stars or planets by the moon; rules for deducing the longitude of a place from observations of eclipses of the sun or occultations; a new and short method of calculating the altitude and longitude of the *nonagesimal* degree of the ecliptic; solutions of several useful problems of *Nautical Astronomy*, and an improvement of Napier's rules for the solution of *spheric triangles*. Several new tables were added. The table of latitudes and longitudes is much increased and corrected.

Also an entirely new article is given in this edition on the method of finding the latitudes by two altitudes of the same, or of different objects: the solutions being direct and simple, embracing all the cases of the problem: a point which has not been attended to in some works of celebrity. This is an important addition to the present work, and it is recommended to the consideration of navigators.

The tables published separately in the Appendix of the first edition are introduced into the body of this work, and are extended so as to render the use of them more simple. The short and easy method of working a lunar observation, published in that Appendix, which has one great advantage over all other approximate methods, in the manner of applying the corrections (all them being additive) is here explained and illustrated by several examples.‡ Two other methods of correcting the apparent distance are given; one being that invented by the author of this work in the year 1795;

* The works chiefly consulted were those published by Maskelyne, Robertson, Patoun, Rios, &c. and a treatise on "Seamanship," published at London in 1795. In this new edition, the work of the Chevalier de Borda, entitled "Description et Usage du Cercle de Reflection," &c. has also been used.

† In the third edition of that work the errors of the table of proportional logarithms are corrected.

‡ This method was communicated to Mr. De Lambre, who published an account of it in the "Connaissance des temps pour l'année, 1808."

the other an improvement of Witchell's method, in which, without altering materially the calculation, the number of cases is considerably reduced.

To promote the accuracy of the successive editions of this work, all the tables (which admit of it) have been stereotyped, namely, Tables I. II. III. V. VII. IX. X. XI. XII. XIII. XIV. XV. XVI. XVII. XVIII. XIX. XX. XXI. XXII. XXIII. XXIV. XXV. XXVI. XXVII. XXVIII. XXIX. XXX. XXXI. XXXII. XXXIII. XXXIV. XXXV. XXXVI. XXXVIII. XXXIX. XL. XLI. XLII. XLIII. XLIV. and XLV. Since the publication of the first stereotype edition, these Tables have been carefully examined by the author, and the few mistakes which were discovered, have been corrected in the plates.

Any person who wishes to examine the tables, may do it by the methods used for that purpose, which will here be explained with some additional remarks.

TABLES I. and II. were calculated by the natural sines taken from the fourth edition of Sherwin's logarithms, which were previously examined, by differences; when the proof-sheets of the first edition were examined, the numbers were again calculated by the natural sines in the second edition of Hutton's logarithms; and if any difference was found, the numbers were calculated a third time by Taylor's logarithms.

TABLE III. contains the meridional parts for every degree and minute of the quadrant, calculated by the following rule, viz.

$$M = T \times 0.0007915704468.$$

in which T is the log-tangent less radius of half the latitude increased by 45° taken to seven places of figures, reckoned as integers, and M is the meridional parts of that latitude in miles.

TABLE IV. contains the declination of the sun, which was compared with the Nautical Almanacs for the years 1824, 1825, 1826, and 1827, and marked to the nearest minute.

TABLE IV. A. The Equation of Time, for the years 1824, 1825, 1826, and 1827.

TABLE V. contains the correction of the sun's declination, as published by Dr. Maskelyne. The correction taken from this table will rarely differ more than 16 or 17 seconds from the truth.

TABLE VI. contains the mean of the sun's right ascension, taken from the Nautical Almanacs for the years 1824, 1825, 1826, and 1827.

TABLE VI. A. contains the correction for the daily variation of the Equation of Time.

TABLE VII. contains the amplitudes of the sun for various latitudes and declinations calculated by Taylor's logarithms by this rule:

$$\text{Log. sec. lat.} + \text{Log. sine declination} - 10.0000000 = \text{Log. sine amplitude.}$$

TABLE VIII. contains the right ascensions and declinations of 76 stars of the first and second magnitudes, with their annual variations, adapted to the beginning of the year 1820. This table was formed from that published by the Astronomer Royal at Greenwich (Mr. Pond) in the Nautical Almanac for 1823, with the addition of a number of stars from the Catalogue of Baron Von Zach.

TABLE IX. contains the time of the sun's rising and setting, calculated by Taylor's logarithms by this rule:

$$\text{Log. cos. hour} = \text{Log. tang. declin.} + \text{Log. tang. latitude} - 10.0000000.$$

Table X. contains the distances at which any object is visible at sea, calculated by the rule given in § 195 of Vince's Astronomy, in which the terrestrial refraction was noticed: this circumstance was neglected by Robertson, Moore, and others, and of course their tables are erroneous. The rule given by Mr. Vince, expressed in logarithms, is this:

$$0.12155 + \text{Half log. of height in feet} = \text{Log. of dist. in statute miles.}$$

In reducing the rule to logarithms, the radius of the earth was called 20911790 feet, which agrees nearly with the mean value given in De La Lande's Astronomy.

TABLE XI. is a common table of proportional parts, the construction of which does not need any explanation.

Prop. log. $T=4.0334738$ —log. of T in seconds, neglecting the three right hand figures of the remainder.

TABLE XXIII. was first constructed by Mr. Douwes of Amsterdam, about the year 1740, for which he received £.50 of the Commissioners of Longitude in England. This table was published in the first and second editions of the Requisite Tables; in the former of which it was carried as far as six hours; in the latter the table of Log. Rising was extended to 9 hours; in the present edition of this work it is extended to 12 hours. The numbers in this table are easily deduced from the log. sines, log. co-secants, and log. versed sines of the hour to which they correspond. Thus, if the time, opposite to any number of these tables turned into degrees, is H , we shall have

Log. $\frac{1}{2}$ elapsed time of $H = \log. \text{co-secant } H - 10.0000000$

Log. middle time $= \log. \text{sine } H - 4.6989700$

Log. rising $H \left\{ \begin{array}{l} = \log. \text{versed sine } H - 5.0000000 \\ = 2 \times \log. \text{sine } \frac{1}{2} H - 14.6989700 \end{array} \right.$

By means of these formulæ, the numbers of Table XXIII. were calculated by Sherwin's, Hutton's and Taylor's logarithms, and above a thousand errors were discovered in the second edition of the Requisite Tables, most of which were in the additional three hours (from six to nine hours) not published in the first edition. About two thirds of these additional numbers differ from their true values by one or two units.

TABLE XXIV. was compared with Sherwin's and Hutton's Tables, and a few errors corrected.

TABLE XXV. contains the log. sines, log. tangents, &c. corresponding to points and quarter points of the compass. This was compared with Sherwin's, Hutton's, and Taylor's logarithms.

TABLE XXVI. contains the common logarithms of numbers, which was compared with Sherwin's, Hutton's and Taylor's logarithms.

TABLE XXVII. contains the common log. sines, tangents, secants, &c. This was compared with Sherwin's, Hutton's and Taylor's tables. Two additional columns are given in this table, which are very convenient in finding the time from an altitude of the sun. The degrees are marked to 180° , which saves the trouble of subtracting the given angle from 180° when it exceeds 90° .

TABLE XXVIII. was calculated by proportioning the daily variation of the time of the moon's passing the meridian.

TABLE XXIX. contains the correction of the moon's altitude for parallax and refraction, corresponding to the parallax $57' 30''$.

TABLES XXX. and XXXI. are tables of proportional parts, taken from the Requisite Tables, with a few corrections.

TABLE XXXII. contains the variation of the altitude of any heavenly body for one minute of time from noon, for various degrees of latitude and declination. The following method was used in constructing the table:— A and B were calculated for each degree of declination by these formulæ.

Log. $A = \log. 1''.96349 + 2 \log. \cos. \text{declination} - 20.00000.$

Log. $B = \log. A. + \log. \text{tang. declination} - 10.00000.$

and then the correction of the table corresponding to the zenith distance Z ($= \text{Lat.} + \text{Dec.}$) was found by this formulæ. $A \times \text{co-tang. } Z \pm B$. To facilitate the computation of these numbers, a table of the products of A by the whole numbers from 1 to 9 was calculated.

TABLE XXXIII. contains the squares of the minutes and parts of a minute corresponding to every second from $0''$ to $12' 59''$. This requires no explanation.

TABLE XXXIV. contains the error of an observed angle arising from a deviation of $1'$ in the parallelism of the surfaces of the central mirror, those surfaces being supposed to be perpendicular to the plane of the instrument. The correction in the fifth column of this table corresponding to any angle

TABLE XLV. The arguments at the side being B and $12-B$ hours, and the second difference at the top A , the correction of this table will be $A \times B(12-B)$

288

TABLE XLVI. contains the Latitudes and Longitudes of the most remarkable ports, harbours, &c. in the world. Great alterations were made in this table in the fifth edition, particularly by the insertion of more than thirteen hundred additional places in the India Seas and in the Pacific Ocean, besides various corrections in other parts of the world, consulting the latest and best authorities. Several corrections and additions have also been made in the present edition.

TABLE XLVII. contains the times of high water on the full and change of the moon, with the vertical rise of the tide, at many ports, harbours, &c. in the world. This table (like the preceding) depending wholly on observations, is therefore liable to be erroneous, though great pains have been taken to make it as correct as possible.

TABLE XLVIII. (Appendix, pages 616 and 617) contains the variation of the altitude of an object arising from a change of 100 seconds in the declination.

Most of the tables of this collection have been republished in London in several editions of a work having the following title: "*The Improved Practical Navigator, originally written and calculated by NATHANIEL BOWDITCH; revised, recalculated, and newly arranged, by THOMAS KIRBY.*" But a number of mistakes have been made in printing the Tables of Mr. Kirby's first edition, some of which have been taken notice of by Dr. Mackay, in the preface of his "*Complete Navigator*;" and as the manner in which those mistakes are mentioned might lead the reader to suppose that the same errors existed in the American Tables, it is thought proper explicitly to state, that *not one* of the "many errors and contradictions," Doctor Mackay has mentioned, is to be found therein.

It may be observed that the first method of working double altitudes, given in page 133, is an improvement of a method published by Mr. Ivory.

	Page.		Page.
To find the distance of the land in order to calculate the dip	109	Second method of finding the apparent time at sea	156
To find the sun's declination	110	Third method of finding the apparent time at sea	158
Variation of the compass	111	To find the apparent time by an altitude of a fixed star	158
To observe an amplitude or azimuth by the compass	112	To regulate a watch by equal altitudes of the sun	160
To calculate the true amplitude	112	To find the longitude at sea by lunar observations	162
To calculate the true azimuth	113	Method of finding the stars used in lunar observations	163
Questions to exercise the learner in calculating an azimuth	114	General observations on the taking a lunar observation	164
Having the true and magnetic amplitude or azimuth, to find the variation	114	To work a lunar observation	166
To calculate the variation by azimuths observed at equal altitudes before and after passing the meridian	115	Examples of lunar observations	168
Variation observed	117	Second method of working a lunar observation	174
On the dip of the magnetic needle	119	Witchell's improved method of finding the true distance	175
To find the latitude by a meridian altitude of the sun or fixed star	120	Method of taking a lunar observation when you have only one observer	176
To find the time of the moon's passing the meridian	123	To calculate the sun's altitude at any time	178
To find the moon's declination	124	To calculate the altitude of any star	178
To find the latitude by the moon's meridian altitude	125	To calculate the altitude of the moon	180
To find the latitude by the meridian altitude of a planet	127	To find the longitude by the eclipses of Jupiter's satellites	181
To find the latitude by double altitudes	128	To find the longitude by an eclipse of the moon	181
—— of the sun	128	To find the longitude by a time-keeper or chronometer	182
—— of a star	129	To regulate a chronometer by lunar observations	185
—— of a planet	129	To find the longitude by a variation chart	185
—— of the moon	130	Problems useful in navigation	186
—— of two different objects, taken within a few minutes of each other, by one observer	130	To find the difference between the true and apparent directions of the wind	191
—— of two different objects, taken at different times	131	To determine the height of a mountain by barometers	192
First method	133	Mensuration	193
Second method	138	Gauging	197
Third method	142	Surveying	199
Questions to exercise the learner in working double altitudes	148	To find the content of a field by the table of diff. lat. and departure	201
To find the latitude by one altitude of the sun, having your watch previously regulated	148	To survey a coast in sailing along shore	203
To find the latitude by the mean of several altitudes of the sun taken near noon by a sextant or circle	150	To survey a harbour by observations on shore	205
To find the latitude on shore by means of an artificial horizon	152	Methods of surveying a small bank or shoal where great accuracy is required	207
To find the latitude by the polar star	156		
To find the time at sea and regulate a watch	154		
Examples to exercise the learner in finding the apparent time	156		

ARRANGEMENT OF THE TABLES.

	Table.		Table.
DIFFERENCE of latitude and departure for points	I	To find the time of the moon's passing the meridian	XXVIII
Ditto, for degrees	II	Correction of the moon's altitude for parallax and refraction	XXIX
Meridional parts	III	To find the moon's declination	XXX
Sun's declination	IV	To find the sun's right ascension	XXXI
Equation of Time	IV	Variation of the sun's altitude in one minute from noon	XXXII
For reducing the Sun's declination	V	To reduce the numbers of Table XXXII. to other given intervals from noon	XXXIII
Sun's right ascension	VI	Errors arising from a deviation of one minute in the parallelism of the surfaces of the central mirror	XXXIV
Correction for the daily variation of the Equation of Time	VI	Error arising from a deviation of the telescope from a plane parallel to the plane of the instrument	XXXV
Amplitudes	VII	Correction of the mean refraction for various heights of the thermometer and barometer	XXXVI
Right ascensions and declinations of the fixed stars	VIII	Longitudes and Latitudes of the fixed stars	XXXVII
Sun's rising and setting	IX	Reduction of latitude and horizontal parallax	XXXVIII
For finding the distance of terrestrial objects at sea	X	Aberration of the planets in longitude	XXXIX
Proportional parts	XI	Equation of the equinoxes in longitude	XL
Refraction of the heavenly bodies	XII	Aberration of the fixed stars in latitude and longitude	XLI
Dip of the horizon	XIII	Aberration of the fixed stars in right ascension and declination	XLII
Sun's parallax in altitude	XIV	Nutation in right ascension and declination	XLIII
Augmentation of the moon's semidiameter	XV	Augmentation of the moon's semidiameter, found by nonagesimal	XLIV
Dip for different heights and distances	XVI	Equation of second differences	XLV
To find the correction and logarithm of a lunar observation when a star is used	XVII	Table of latitudes and longitudes	XLVI
To find the correction and logarithm of a lunar observation when the sun is used	XVIII	Tide Table	XLVII
To find the correction and logarithm of a lunar observation depending on the moon's altitude	XIX	Table, shewing the variation of the altitude of an object arising from a change of 100 seconds in its declination, (page 616)	XLVIII
For finding the third correction of a lunar observation	XX		
(New Form) Corrections in seconds <i>additive</i> . See Appendix, page 618	XX		
For turning degrees and minutes into time, and the contrary	XXI		
Proportional logarithms	XXII		
For finding the latitude by two altitudes of the sun	XXIII		
Natural sines and co-sines	XXIV		
Log. sines, tangents, &c. to points and quarter points	XXV		
Logarithms of numbers	XXVI		
<i>Logarithmic sines, tangents, and secants</i>	XXVII		

SIGNS AND ABBREVIATIONS USED IN THIS WORK.

- +** Is the sign of addition, and denotes that whatever number or quantity follows the sign, must be added to those that go before it, thus $9+8$ signifies that 8 is to be added to 9. Or $A+B$ implies that the quantities represented by A and B are to be added. The sign $+$ is called the *positive sign*.
- The sign of subtraction; and denotes that the number following it must be subtracted from those going before it, thus $7-5$, signifies that 5 must be subtracted from 7. The sign $-$ is called the *negative sign*.
- ×** Is the sign of multiplication, and shows that the numbers placed before and after it are to be multiplied, thus, 7×9 signifies 7 multiplied by 9, which makes 63; and $7 \times 8 \times 2$ signifies the continued product of 7 by 8 and by 2, which makes 112. Multiplication is also denoted by placing a point between the quantities to be multiplied; thus $A.B$ signifies that A is to be multiplied by B.
- ÷** Is the sign of division, and signifies that the number that stands before it is to be divided by the number following it, as $72 \div 12$ shows that 72 is to be divided by 12. Division may also be denoted by placing two points between the numbers, thus, $72 : 12$ represents 72 divided by 12 or by placing the numbers thus, $\frac{72}{12}$ which signifies 72 divided by 12.
- ()** or . Either of these marks is used for connecting numbers together, thus, $3+4 \times 6$, or $(3+4) \times 6$, signifies that the sum of 3 and 4 is to be multiplied by 6.
- =** Is the sign of equality, and shows that the numbers or quantities placed before it are equal to those following it: thus $3 \times 12 = 36$. Or 8 multiplied by 12 are equal to 96, and $7+2 \times 4 = 38$.
- ::** Is the sign of proportion, and is marked thus, $7 : 14 :: 10 : 20$, that is, as 7 is to 14, so is 10 to 20. Or $A : B :: C : D$, that is, as A is to B, so is C to D.
- °** Signifies degrees; thus, 45° represents 45 degrees.
- '** Signifies minutes; thus, $24'$ or 24 minutes,
- "** Signifies seconds; thus, $44''$, or 44 seconds.
- '''** Signifies thirds or sixtieth parts of seconds; thus, $44'''$, or 44 thirds.
- S.** Signifies sine. **N. S.** Signifies Natural sine.
- Sec.** Signifies Secant.
- Tan.** Signifies Tangent.
- Co-sine, Co-tangent, or Co-secant** of an arch signifies the sine, tangent or secant of the complement of that arch respectively.
- <** Signifies Angle; with an s at top Angles, $\angle s$.
- ∠** Angled,
- △** Signifies Triangle. $\triangle's$ Triangles.
- Signifies a square.
- ☉** or **☽** the Sun. **☾** or **☾** the Moon. ***** a Star. **L. L.** Lower Limb. **U. L.** Upper Limb. **N. L.** Nearest Limb. **S. D.** Semi-diameter. **P. L.** Proportional Logarithm. **N. A.** Nautical Almanac. **Z. D.** Zenith Distance. **D. R.** Dead Reckoning.

DIRECTIONS FOR THE BINDER.

PLATE	I.	TO FRONT THE TITLE PAGE.	
_____	II.	TO FRONT PAGE	20.
_____	III.	TO FRONT PAGE	44.
_____	IV.	TO FRONT PAGE	46.
_____	V.	TO FRONT PAGE	50.
_____	VI.	TO FRONT PAGE	52.
_____	VII.	TO FRONT PAGE	96.
_____	VIII.	TO FRONT PAGE	106.
_____	IX.	TO FRONT PAGE	110.
_____	X.	TO FRONT PAGE	203.
_____	XI.	TO FRONT PAGE	205.
_____	XII.	TO FRONT PAGE	582.

DECIMAL ARITHMETIC.

MANY persons who have acquired considerable skill in common Arithmetic, are unacquainted with the method of calculating by decimals, which is of great use in Navigation; for which reason it was thought proper to prefix the following brief explanation.

Fractions or *Vulgar Fractions* are expressions for any assignable part of an unit; they are usually denoted by two numbers, placed the one above the other, with a line between them: thus, $\frac{1}{4}$ denotes the fraction one-fourth, or one part out of four of some whole quantity, considered as divisible into four equal parts. The lower number 4 is called the *denominator* of the fraction, showing into how many parts the whole or integer is divided; and the upper number 1, is called the *numerator*, and shows how many of those equal parts are contained in the fraction. And it is evident that if the numerator and denominator be varied in the same ratio, the value of the fraction will remain unaltered: thus if the numerator and denominator of the fraction $\frac{1}{4}$ be multiplied by 2, 3, or 4, &c. the fractions arising will be $\frac{2}{8}$, $\frac{3}{12}$, $\frac{4}{16}$, &c. which are evidently equal to $\frac{1}{4}$.

Decimal Fraction is a fraction whose denominator is always an unit with some number of ciphers annexed, the numerators of which may be any numbers whatever; as $\frac{2}{10}$, $\frac{25}{100}$, $\frac{15}{1000}$, &c. And as the denominator of a decimal is always one of the numbers 10, 100, 1000, &c. the inconvenience of writing these denominators may be avoided, by placing a point between the integral and the fractional part of the number; thus $\frac{2}{10}$ is written .2; and $\frac{15}{100}$ is written .15; the *mixed* number $3\frac{15}{100}$, consisting of whole numbers and fractional ones is written 3.15.

In setting down a decimal fraction, the numerator must consist of as many places as there are ciphers in the denominator; and if it has not so many figures the defect must be supplied by placing ciphers before them; thus, $\frac{16}{100} = .16$, $\frac{16}{1000} = .016$, $\frac{16}{10000} = .0016$, &c. And as ciphers on the right hand side of integers increase their value in a tenfold proportion, as 2, 20, 200, &c. so when set on the left hand of decimal fractions, they decrease their value in a tenfold proportion, as 2, .02, .002, &c. but ciphers set on the right hand of these fractions make no alteration in their value, neither of increase or decrease; thus, .2 is the same as .20 or .200. The common arithmetical operations are performed the same way in decimals, as they are integers; regard being had only to the particular notation, to distinguish the integral from the fractional part of a sum.

ADDITION OF DECIMALS.

Addition of decimals is performed exactly like that of whole numbers, placing the numbers of the same denomination under each other, in which case the decimal separating points will range straight in one column.

EXAMPLES.

Miles.	Feet.	Inches.
26.7	1.26	272.3267
32.15	2.31	.0134
143.206	1.785	2.1576
.003	2.0	31.4
<hr/>	<hr/>	<hr/>
Sum 202.059	7.355	305.8977
	C	

DECIMAL ARITHMETIC.

SUBTRACTION OF DECIMALS.

Subtraction of decimals is performed in the same manner as in whole numbers, by observing to set the figures of the same denomination and the separating points directly under each other.

EXAMPLES.

From 31.267
Take 2.63

Diff. 28.637

36.75
.028

36.724

1.254
.316

.938

1364.2
25.163

1339.037

MULTIPLICATION OF DECIMALS.

Multiply the numbers together the same as if they were whole numbers, and point off as many decimals from the right hand as there are decimals in both factors together; and when it happens that there are not so many figures in the product as there must be decimals, then prefix as many ciphers to the left hand as will supply the defect.

EXAMPLE I.

Multiply 3.25 by 4.5

3.25
4.5

1.625
13.00

Answer 14.625

In one of the factors is one decimal and in the other two, their sum 3 is the number of decimals of the product.

EXAMPLE II.

Multiply 0.5 by 0.7

0.5
0.7

0.35 Answer.

EXAMPLE III.

Multiply 3.25 by .05

3.25
.05

.1625 Product.

EXAMPLE IV. Multiply .17 by .06

.17
.06

Answer .0102

In each of the factors are two decimals, the product ought therefore to contain 4, and there being only three figures in the product I prefix a cipher.

EXAMPLE V. Multiply .18 by 24.

.18
24

72
36

Answer 4.32

EXAMPLE VI. Multiply 36.1 by 2.5

36.1
2.5

18.05
72.2

Answer 90.25

DIVISION OF DECIMALS.

Division of decimals is performed in the same manner as in whole numbers; only observing that the number of decimals in the quotient must be equal to the excess of the number of decimals of the dividend above those of the divisor.—When the divisor contains more decimals than the dividend, ciphers must be affixed to the right hand of the latter to make the number equal or exceed that of the divisor.

EXAMPLE I.

Divide 14.625 by 3.25

3.25)14.625(4.5

1300

1625

1625

In this example there are 2 decimals in the divisor, and 3 in the dividend, hence there is one decimal in the quotient.

EXAMPLE II.

Divide 0.35 by 0.7

.7).35(.5
.35

EXAMPLE III.

Divide 3.1 by .0062

Previous to the division I affix a number of ciphers to the right hand of 3.1, which does not alter its value.

.0062)3.100000(500.00

310

0000

Therefore the answer is 500.00 or 500.

DECIMAL ARITHMETIC.

3

EXAMPLE IV.

Divide 9.6 by .06

$$\begin{array}{r} .06 \overline{) 9.60} \\ \underline{.06} \\ 160 \end{array}$$

160 Answer.

Here by affixing a cipher to 9.6 it becomes 9.60, and has then 2 decimals in it, which is the same number as is in the divisor, therefore the quotient is an integer number.

EXAMPLE V.

Divide 17.256 by 1.16

$$\begin{array}{r} 1.16 \overline{) 17.25600} \\ \underline{116} \\ 565 \\ \underline{464} \\ 1016 \\ \underline{928} \\ 880 \\ \underline{812} \\ 680 \\ \underline{580} \\ 100 \end{array}$$

100

REDUCTION OF DECIMALS.

If you wish to reduce a vulgar fraction to a decimal, you may add any number of ciphers to the numerator, and divide it by the denominator, the quotient will be the decimal fraction; the decimal point must be so placed that there may be as many figures to the right hand of it as you added ciphers to the numerator; if there are not as many figures in the quotient, you must place ciphers to the left hand to make up the number.

EXAMPLE I. Reduce $\frac{1}{2}$ to a decimal.

$$\begin{array}{r} 5 \overline{) 10} \\ \underline{5} \\ 5 \end{array}$$

.5 Answer.

EXAMPLE II. Reduce $\frac{3}{8}$ to a decimal.

$$\begin{array}{r} 5 \overline{) 3.000} \\ \underline{25} \\ 50 \\ \underline{40} \\ 100 \\ \underline{90} \\ 100 \end{array}$$

.375 Answer.

EXAMPLE III. Reduce 3 inches to the decimal of a foot.

Since 12 inches=1 foot, this fraction is $\frac{3}{12}$.

$$\begin{array}{r} 12 \overline{) 3.00} \\ \underline{24} \\ 60 \\ \underline{60} \\ 0 \end{array}$$

.25 Answer.

EXAMPLE IV. Reduce $3\frac{1}{2}$ inches to the decimal of a foot.

$3\frac{1}{2} = \frac{7}{2}$: this divided by 12 is $\frac{7}{24}$.

$$\begin{array}{r} 24 \overline{) 7.000} \\ \underline{48} \\ 220 \\ \underline{216} \\ 40 \\ \underline{24} \\ 16 \end{array}$$

16

EXAMPLE V. Reduce 1 foot and 6 inches to the decimal of a yard.

Here 1 foot 6 inches=18 inches.

And 1 yard=36 inches, therefore this fraction is $\frac{18}{36}$.

$$\begin{array}{r} 36 \overline{) 18.0} \\ \underline{180} \\ 0 \end{array}$$

180

If you have any decimal fraction, it is easy to find its value in the lower denominations of the same quantity; thus if the fraction was the decimal of a yard, by multiplying it by 3 we have its value in feet and parts; if we multiply this by 12, the product is its value in inches and parts; and in the same manner the values may be obtained in other cases.

EXAMPLE VI.

Required the value of 3.25 yards.

$$\begin{array}{r} 3.25 \\ \times 3 \\ \hline .75 \\ \times 12 \\ \hline 9.00 \end{array}$$

.75

12

9.00

Answer 3 yards, 0 feet, 9 inches.

EXAMPLE VII.

Required the value of 7.251 days.

$$\begin{array}{r} 7.251 \\ \times 24 \\ \hline 924 \\ \times 60 \\ \hline 5.544 \\ \times 60 \\ \hline 32.640 \\ \times 60 \\ \hline 38.400 \end{array}$$

24

924

462

5.544

60

32.640

60

38.400

Answer 7 days, 5 hours, 52 minutes, and 38 seconds.

GEOMETRY.

GEOMETRY is the Science which treats of the description, properties, and relations of magnitudes in general, of which there are three kinds or species, viz. a line which has only length without either breadth or thickness; a superficies, comprehended by length and breadth, and a solid, which has length, breadth, and thickness.

I.

A **POINT** considered mathematically has no length, breadth, or thickness.

II.

A **STRAIGHT LINE OR RIGHT LINE** is the shortest distance between the two points which limits its length, as

A———C

III.

A **PLANE SUPERFICES** is that in which any two points being taken, the straight line between them lies wholly in that surface.

IV.

PARALLEL LINES are such as are in the same plane and which extended infinitely do never meet, as AB, DC.

A———B

D———C

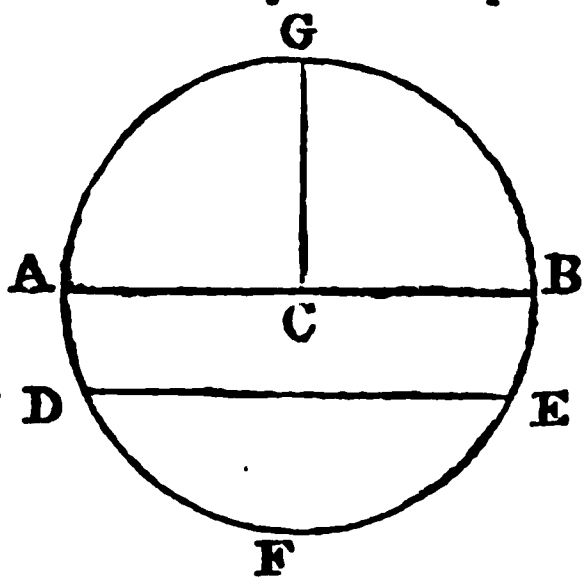
V.

A **CIRCLE** is a plane figure, bounded by an uniform curve line; it is commonly described with a pair of compasses; one point of which is fixed, whilst the other is turned round to the place where the motion first began; the fixed point is called the **CENTRE**, and the line described by the other point is called the **CIRCUMFERENCE**.

VI.

The **RADIUS** of a circle, or **SEMIDIAMETER**, is a right line drawn from the centre to the circumference, as AC; or it is that line which is taken between the points of the compasses to describe the circle.

A **DIAMETER** of a circle is a right line drawn through the centre and terminated at both ends by the circumference, as ACB, and is the double of the radius AC. A diameter divides the circle, and its circumference into two equal parts.



VII.

An **ARCH** of a circle is any part or portion of the circumference, as DFE.

VIII.

The **CHORD** of an arch is a straight line joining the ends of the arch; it divides the circle into two unequal parts, called **SEGMENTS**, and is a chord to them both, as DE is the chord of the arches DFE and DGE.

IX.

A **SEMICIRCLE**, or half circle, is a figure contained under a diameter and the arch terminated by that diameter, as AGB or AFB. Any part of a circle contained between two radii and an arch, is called a **SECTOR**.

X.

A **QUADRANT** is half a semicircle, or one-fourth part of a whole circle, as the figure CAG.

NOTE. All circles, whether great or small, are supposed to have their circumference divided into 360 equal parts, called degrees, and each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds, and so on into thirds, fourths,* &c. and an arch is said to be of as many degrees as it contains parts of the 360, into which the circumference is divided.

* A new division of the circumference of the circle has lately been adopted by several eminent French mathematicians, in which the quadrant is divided into 100°, each degree into 100', each minute into 100'', &c. and tables of logarithms have been published conformable thereto. The general adoption of this division would tend greatly to facilitate most of the calculations of navigation and astronomy.

GEOMETRY.

XI.

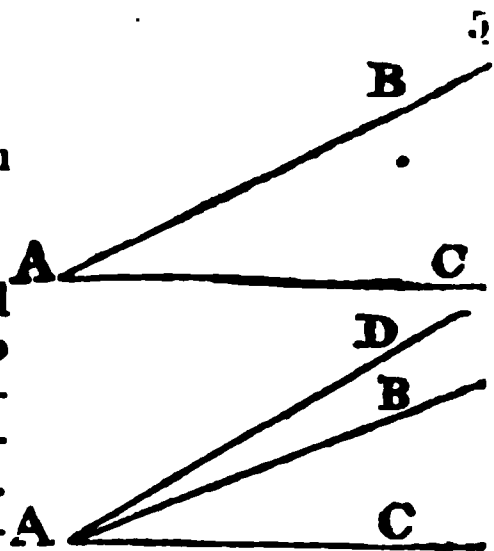
An **ANGLE** is the inclination of two lines which meet, but not in the same direction.

An angle is usually expressed by the letter placed at the angular point, as the angle A. But when two or more angles are at the same point, it is then necessary to express each by three letters, and the letter at the angular point is placed between the two.

Thus, the angle formed by the lines AB, AC, is called the angle BAC or CAB, and that formed by AB, AD, is called the angle BAD, or DAB.

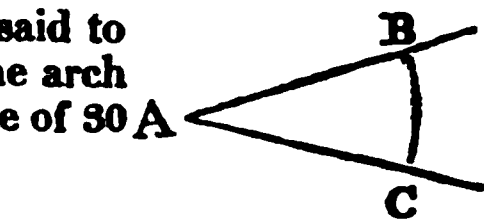
An angle is measured by the arch of a circle comprehended between the two legs that form the angle, the centre of the circle being the angular point.

Thus the angle A is measured by the arch BC described round the point A as a centre, and the angle is said to be of as many degrees as the arch is, that is, if the arch BC is 30°, then the angle BAC, is said to be an angle of 30 degrees.



XII.

If a right line AB, fall upon another DC, so as to incline neither to the one side nor the other, but makes the angles ABC, ABD, equal to each other; then the line AB is said to be *perpendicular* to the line DC, and each of these angles is called a *right angle*, being each equal to a quadrant or 90°; because the sum of the two angles ABC, ABD, is measured by the semicircle DAC, described on the diameter DBC, and centre B.



XIII.

An **ACUTE ANGLE** is less than a right angle, as ABC.

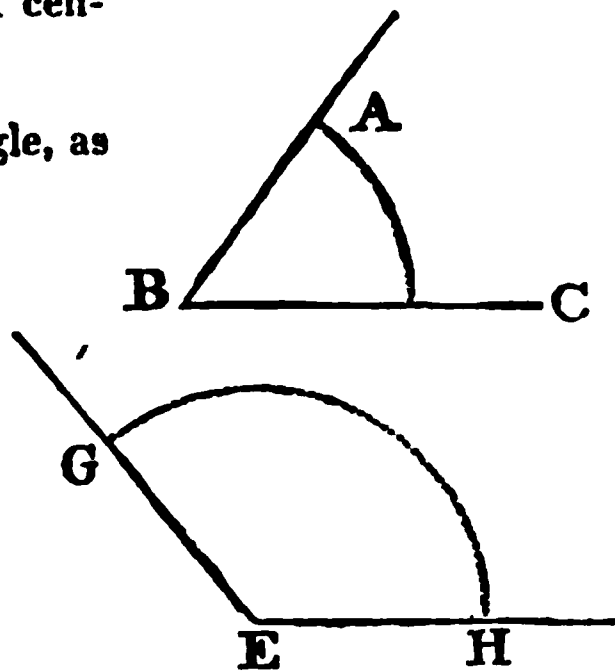
XIV.

An **OBTUSE ANGLE** is greater than a right angle, as GEH.

The least number of right lines that can include a space, are three which form a figure called a *Triangle*, consisting of six parts, viz. three sides and three angles: it is distinguished into three sorts, viz. a right angled triangle, an obtuse-angled triangle, and an acute angled triangle.

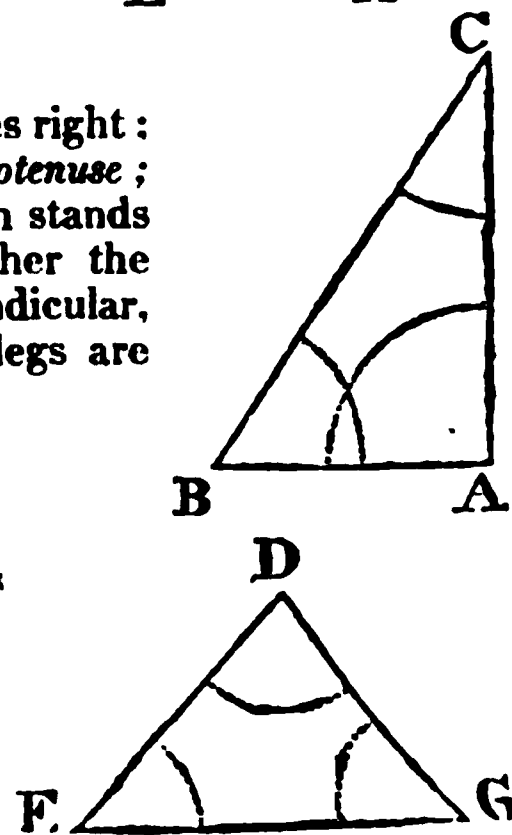
XV.

A **RIGHT-ANGLED TRIANGLE** has one of its angles right: the side opposite the right angle is called the *hypotenuse*; and the other two sides are called legs; that which stands upright, is called the *perpendicular*, and the other the *base*; thus BC is the hypotenuse, AC the perpendicular, and AB the base; the angles opposite the two legs are both acute.



XVI.

An **ACUTE-ANGLED TRIANGLE** has each of its angles acute, as DEG.



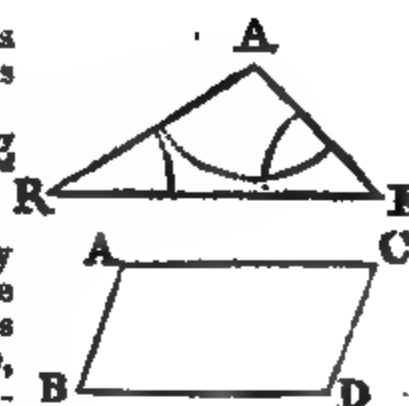
XVII.

AN OBTUSE-ANGLED TRIANGLE has one of its angles obtuse, or greater than a right angle, as RAF ; the other two angles are acute.

NOTE. All triangles that are not right angled, whether they are acute or obtuse, are in general terms called *oblique-angled triangles*, without any other distinction.

XVIII.

A QUADRILATERAL figure is one bounded by four sides, as $ACDB$. If the opposite sides are parallel they are called PARALLELOGRAMS. Thus if AC be parallel to BD , and AB parallel to CD , the figure $ACDB$ is a parallelogram. A parallelogram having all its sides equal, and its angles right, is called a SQUARE, as B . When the angles are right, and the opposite sides only equal, it is called a RECTANGLE, as A .

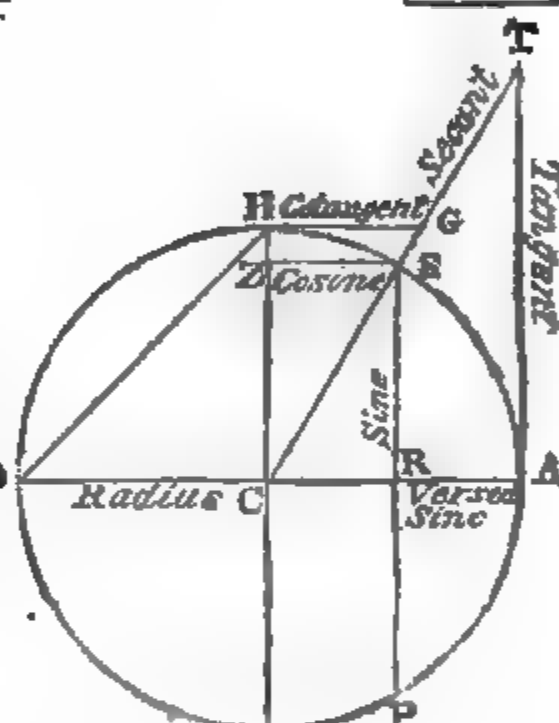


XIX.

The SINE of an arch is a line drawn from one end of the arch perpendicular to a diameter drawn through the other end of the same arch; thus RS is the sine of the arch AS , RS being a line drawn from one end S of that arch, perpendicular to DA which is the diameter passing through the other end A of the arch.

XX.

The Co-SINE of an arch is the sine of the complement of that arch, or of what that arch wants of a quadrant; thus AH being a quadrant, the arch SH is the complement of the arch AS ; SZ is the sine of the arch SH ; or the co-sine of the arch AS .



XXI.

The VERSED SINE of an arch is that part of the diameter contained between the sine and the arch; thus RA is the versed sine of the arch AS , and DCR is the versed sine of the arch DHS .

XXII.

The TANGENT of an arch is a right line drawn perpendicular to the diameter passing through one end of the arch, and terminated by a line drawn from the centre through the other end of the arch; thus AT is the tangent of the arch AS .

XXIII.

The Co-TANGENT of an arch is the tangent of the complement of the arch to a quadrant; thus HG is the tangent of the arch HS , or the co-tangent of the arch AS .

XXIV.

The SECANT of an arch is a right line drawn from the centre through one end of the arch to meet the tangent drawn from the other end; thus CT is the secant of the arch AS .

GEOMETRY.

7

XXV.

The Co-SECANT of an arch is the secant of the complement of that arch to a quadrant, thus CG is the secant of the arch SH, or co-secant of the arch AS.

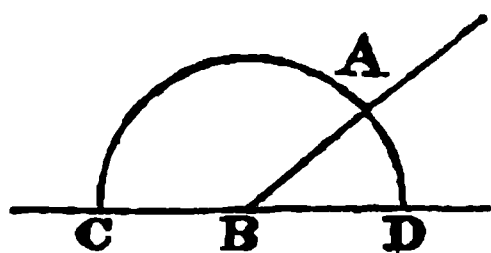
XXVI.

What an arch wants of a semicircle is called the SUPPLEMENT of the arch, thus, the arch DHS is the supplement of the arch AS. The sine, tangent, or secant of an arch, is the same as the sine, tangent, or secant of its supplement; thus, the sine of $80^\circ = \text{sine of } 100^\circ$, and the sine of $70^\circ = \text{sine of } 110^\circ$, &c.

XXVII.

If one line AB fall any way upon another CD, the sum of the two angles ABD, ABC is always equal to two right angles.

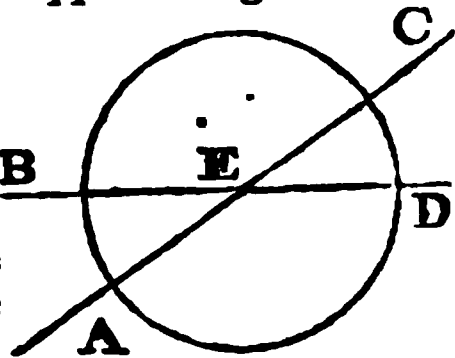
For on the point B as a centre, describe the circular arch CAD, cutting the line CD in C and D; then (by art. 6) this arch is equal to a semicircle, but it is also equal to the sum of the arches CA and AD, the measures of the two angles ABC, ABD: therefore the sum of the two angles is equal to a semicircle, or two right angles. Hence it is evident that all the angles which can be made from a point in any line, towards one side of the line, are equal to two right angles, and that all the angles which can be made about a point, are equal to four right angles.



XXVIII.

If a line AC cross another BD in the point E, the opposite angles will be equal, viz. BEA = CED, and BEC = AED.

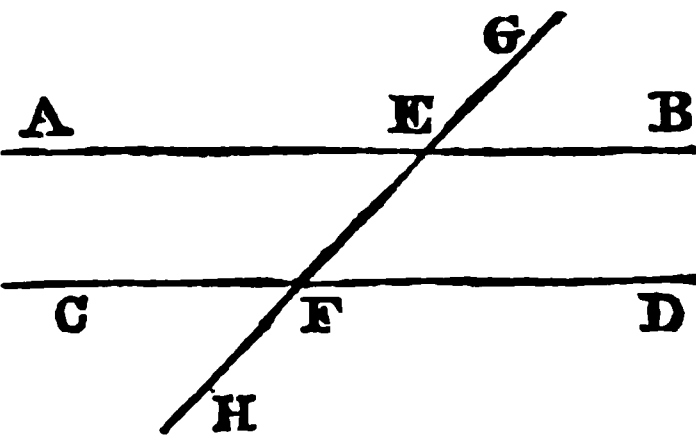
Upon the point E as a centre, describe the circle ABCD: then it is evident that ABC is a semicircle, as also BCD (by the 6th) therefore the arch ABC = arch BCD, taking from both the common arch BC, there remains AB = CD, that is, the angle BEA equal to the angle CED. After the same manner we may prove that the angle BEC is equal to the angle AED.



XXIX.

If a line GH cross two parallel lines, AB, CD, it makes the external opposite angles equal to each other, viz. GEB = CFH and AEG = HFD.

For since AB and CD are parallel to each other, they may be considered as one broad line, and GH crossing it; then the vertical or opposite angles GEB, CFH are equal (by art. 28) as also AEG = HFD.



XXX.

If a line GH cross two parallel lines AB, CD (see the figure) the alternate angles AEF and EFD, or CFE and FEB are equal.

For GEB = AEF (art. 28) as also CFH = EFD (by the same art.) but GEB = CFH by the last. Therefore AEF is equal to EFD; in the same way may we prove FEB = CFE.

XXXI.

If a line GH cross two parallel lines AB, CD (see the preceding figure) the external angle GEB is equal to the internal opposite one EFD, or AEG equal to CFE.

For the angle AEF is equal to the angle EFD by the last, and AEF = GEB (by art. 28) therefore GEB = EFD; in the same way we may prove AEG = CFE.

XXXII.

If a line GH cross two parallel lines AB, CD (see the preceding figure) the sum of the two internal angles BEF and DFE, or AEF and CFE is equal to two right angles.

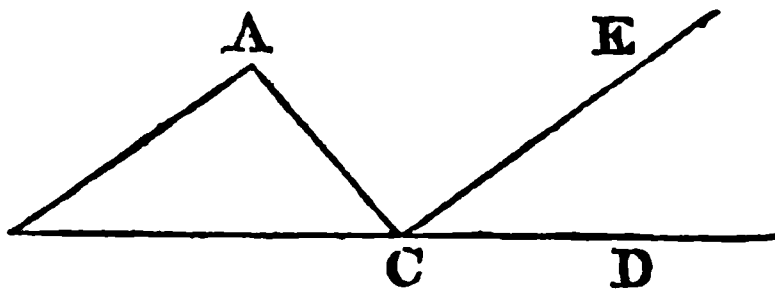
For since the angle GEB is equal to the angle EFD (by the last) to both

add the angle BEF , and we have $GEB + BEF = BEF + EFD$, but $GEB + BEF = \text{two right angles}$ (*art. 27.*) Hence $BEF + EFD = \text{two right angles}$; and in the same manner we may prove $AEF + CFE = \text{two right angles}$.

XXXIII.

In any triangle ABC, one of its legs, as BC being produced towards D, the external angle ACD is equal to the sum of the internal and opposite angles ABC, BAC.

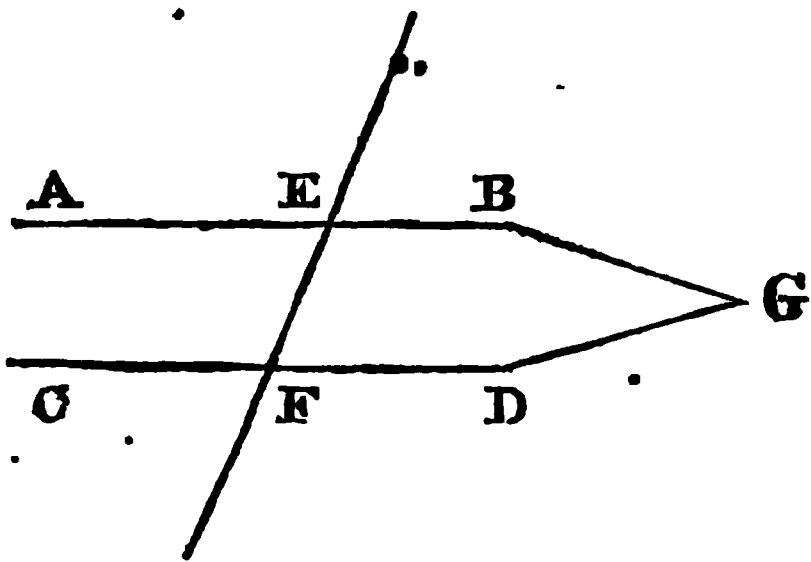
To prove this, through C draw CE parallel to AB; then since CE is parallel to AB and the lines AC, BD cross them, the angle $ECD = ABC$ (*by article 31*) and $ACE = BAC$ (*by article 30*) B adding these together we have $ECD + ACE = ABC + BAC$; but $ECD + ACE = ACD$, therefore $ACD = ABC + BAC$.



XXXIV.

Hence it may be proved that if any two lines AB and CD, be crossed by a third line EF, and the alternate angles AEF and EFD be equal, the lines AB and CD will be parallel.

For if they are not parallel, they must meet each other on one side of the line EF (suppose at G) and so form the triangle EGF, one of whose sides, GE being produced to A, the exterior angle AEF must (*by the preceding article*) be equal to the sum of the two angles EFG and EGF; but by supposition it is equal to the angle EFG alone; therefore the angle AEF must be equal to the sum of the two angles EFG and EGF, and at the same time equal to EFG alone, which is absurd; therefore the lines AB, CD cannot meet, and must be parallel.



XXXV.

In any right lined triangle ABC, the sum of the three angles is equal to two right angles.

To prove this, you must produce BC (*in the fig. art. 33,*) towards D, then (*by art. 33*) the external angle $ACD = ABC + BAC$, to both add the angle ACB and we have $ACD + ACB = ABC + BAC + ACB$, but $ACD + ACB = \text{two right angles}$ (*by art. 27.*) Hence $ABC + BAC + ACB = \text{two right angles}$; therefore the sum of the three angles of any plain triangle ACB is equal to two right angles.

XXXVI.

Hence in any plain triangle, if one of its angles be known, the sum of the other two will be also known.

For by the last article the sum of all three angles is equal to two right angles or 180° , hence, by subtracting the given angle from 180° , the remainder will be the sum of the other two.

In any right angled triangle, the two acute angles taken together are just equal to a right angle: for all three angles being equal to two right angles, and one angle being right by supposition, the sum of the other two must be equal to a right angle, consequently any one of the acute angles being given, the other one may be found, by subtracting the given one from 90 degrees.

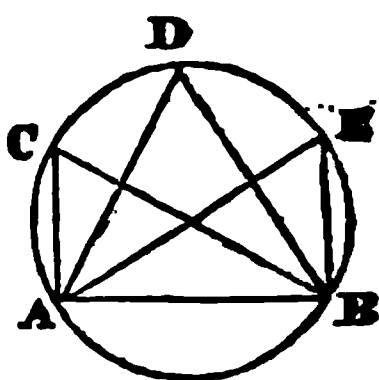
XXXVII.

If in any two triangles ABC, DEF, two legs of the one, AB, AC, be equal to two legs of the other DE, DF, each to each respectively, that is $AB = DE$ and

XLI.

An angle at the circumference is measured by half the arch it subtends.

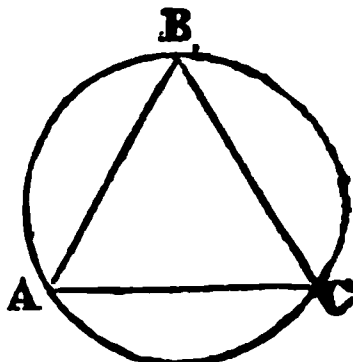
For an angle at the centre standing on the same arch is measured by the whole arch (*by art. 11*); but since an angle at the centre is double that at the circumference, (*art. 40*) it is evident that an angle at the circumference must be measured by half the arch it stands upon. Hence all angles ACB , ADB , AEB , &c. at the circumference of a circle standing on the same chord AB are equal to each other; for they are all measured by the same arch, viz. half the arch AB .



XLII.

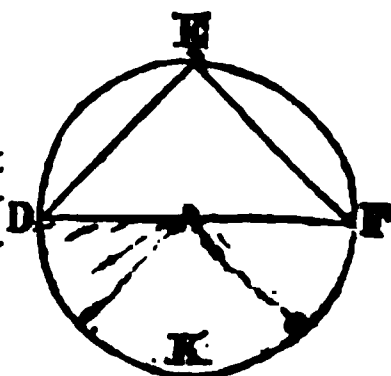
An angle in a segment greater than a semicircle is less than a right angle.

Thus if ABC be a segment greater than a semicircle, the arch AC on which it stands must be less than a semicircle, and the half of it less than a quadrant or a right angle; but the angle ABC in the segment is measured by the half of the arch AC ; therefore it is less than a right angle.



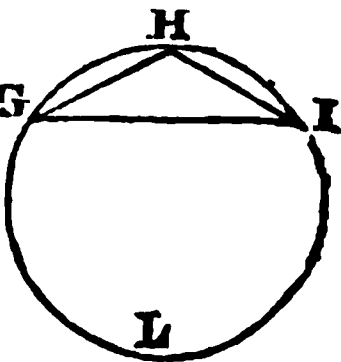
An angle in a semicircle is a right angle.

For since DEF is a semicircle, the arch DKF must also be a semicircle; but the angle DEF is measured by half the arch DKF , that is, by half a semicircle or by a quadrant; therefore the angle DEF is a right one.



An angle in a segment less than a semicircle is greater than a right angle.

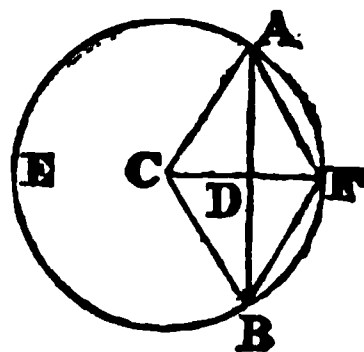
Thus if GHI be a segment less than a semicircle, the arch GLI on which it stands must be greater than a semicircle, and its half greater than a quadrant or right angle: therefore the angle GHI which is measured by half the arch GLI is greater than a right angle.



XLIII.

If from the centre C of the circle ABE , there be let fall the perpendicular CD on the chord AB ; it will bisect the chord in the point D .

Draw the radii CA , CB , then (*by art. 39*) the angle $CBA =$ the angle CAB , and as the angles at D are right, the angle ACD must be equal to the angle BCD (*by art. 38.*) Hence in the triangles ACD , BCD , we have the angle ACD equal to the angle BCD , $CA = CB$ and CD common to both triangles, consequently (*by art. 37*) $AD = DB$, that is, AB is bisected at D .



XLIV.

If from the centre C of the circle ABE there be drawn a perpendicular CD , to the chord AB , and it be continued to meet the circle in F , it will bisect the arch AFB in F . (See the preceding figure.)

For in the last article it was proved that the angle $ACD =$ the angle BCD , hence (*by art. 11*) the arch $AF =$ the arch FB .

XLV.

Any line bisecting a chord at right angles is a diameter.

For since (*by art. 43*) a line drawn from the centre perpendicular to a chord, bisects that chord at right angles, therefore conversely a line bisecting a chord at right angles, must pass through the centre, and consequently be a diameter.

XLVI.

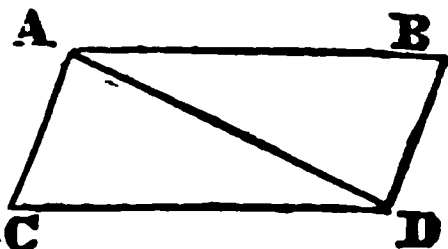
The sine of any arch is equal to half the chord of twice that arch.

For (in the last scheme) AD is the sine of the arch AF, and AF is equal to half the arch AFB and AD half the chord AB, whence the proposition is manifest.

XLVII.

If two equal and parallel lines AB, CD, be joined by two others, AC, BD, these will be also equal and parallel.

To demonstrate this, join the two opposite angles A and D with the line AD; then it is evident that the line AD divides the quadrilateral ACDB into two triangles ABD, ACD, in which AB is equal to CD by supposition, and AD is common to both triangles; and since AB is parallel to CD, the angle BAD is equal to the angle ADC (by art. 30), therefore in the two triangles, the sides AB, AD, and the angle BAD are equal respectively to the sides CD, AD, and the angle ADC; hence (by art. 37) BD is equal to AC, and the angle DAC equal to the angle ADB; therefore (by art. 34) the lines BD, AC, must be parallel.



Cor. Hence it follows that the quadrilateral ABDC is a parallelogram, since the opposite sides are parallel. It is also evident that in any parallelogram, the line joining the opposite angles (called the *diagonal*) as AD, divides the figure into two equal parts, since it has been proved that the triangles ABD, ACD, are equal to each other.

XLVIII.

It follows also from the preceding article, that a triangle ACD (see the preceding figure) on the same base, and between the same parallels with a parallelogram ABDC, is the half of that parallelogram.

XLIX.

From the same article it also follows, that the opposite sides of a parallelogram are equal. For it has been proved, that ABDC being a parallelogram, AB is equal to CD, and AC equal to BD.

L.

All parallelograms on the same or equal bases, and between the same parallels, are equal to each other; that is, if BD and GH be equal, and the lines BH, AF be parallel, the parallelograms ABDC, BDFE and EFHG will be equal to each other.

For AC is equal to EF each being equal to BD (by art. 49) to both add CE and we have AE equal to CF; therefore in the two triangles ABE, CDF; AB is equal to CD, and AE is equal to CF, and the angle BAE is equal to DCF (by art. 31,) therefore



the two triangles ABE, CDF are equal (by art. 37) and taking the triangle CKE from both, the figure ABKC is equal to the figure KDFE, to both which add the little triangle KBD, and we have the parallelogram ABDC equal to the parallelogram BDFE. In the same way it may be proved that the parallelogram EFHG is equal to the parallelogram BDFE; therefore the three parallelograms ABDC, BDFE, and EFHG are equal to each other.

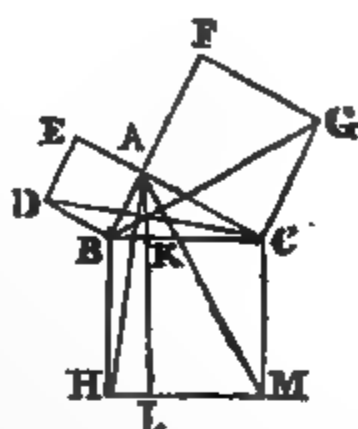
Cor. Hence it follows, that triangles on the same base and between the same parallels are equal, since they are the half of the parallelograms on the same base and between the same parallels (by art. 48.)

LI.

In any right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the two sides. Thus if BAC be a right angled triangle the square of the hypotenuse BC, viz. BCMH, is equal to the sum of the squares made on the two sides AB and AC, viz. to ABDE and ACGF.

To demonstrate this, through the point A draw AKL perpendicular to the hypotenuse BC. Join AH, AM, DC, and BG; then it is evident, that DB

is equal to BA (by art. 18) and BH equal to BC, therefore in the triangles DBC, ABH, the two legs DB, BC of the one are equal to the two legs AB, BH, of the other; and the included angles DBC and ABH are also equal, (for DBA is equal to CBH being both right, to each add ABC and we have DBC equal to ABH) therefore the triangles DBC, ABH are equal (by art. 37) but the triangle DBC is half of the square ABDE (by art. 48) and the triangle ABH is half the parallelogram BKLH (by the same art.) consequently the square ABDE is equal to the parallelogram BKLH. In the same way it may be proved that the square ACGF is equal to the parallelogram KCML. Therefore the sum of the squares ABDE and ACGF is equal to the sum of the parallelograms BKLH and KCML; but the sum of these parallelograms is equal to the square BCMH, therefore the sum of the squares on AB and AC is equal to the square on BC.



Cor. Hence in any right angled triangle, if we have the hypotenuse and one of the legs, we may easily find the other leg, by taking the square of the given leg from the square of the hypotenuse, the square root of the remainder will be the sought leg. Thus if the hypotenuse was 13, and one leg was 5, the other leg would be 12, for the square of 5 is 25, and the square of 13 is 169, subtracting 25 from 169 leaves 144, the square root of which is 12. If both legs are given, the hypotenuse may also be found by extracting the square root of the sum of the squares of the legs; thus if one leg was 6, and the other 8, the square of the first is 36, the square of the second is 64, adding 36 and 64 together gives 100, whose square root is 10, which is the sought hypotenuse.

LII.

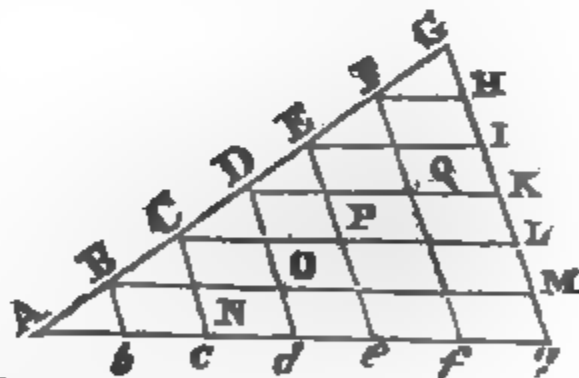
Four quantities are said to be proportional, when the magnitude of the first compared with the second is the same as the magnitude of the third compared with the fourth.

Thus 4, 8, 12 and 24, are proportional, because 4 is half of 8, and 12 is half of 24; and if we take equi-multiples $A \times a$, $A \times b$, of the quantities a and b , and other equi-multiples $B \times a$, $B \times b$, of the same quantities a and b , the four quantities $A \times a$, $A \times b$, $B \times a$, $B \times b$ will be proportional, for $A \times a$ compared with $A \times b$ is of the same magnitude as a compared with b , and $B \times a$ compared with $B \times b$ is also of the same magnitude as a compared with b .

LIII.

In any triangle AGg if a line Ee be drawn parallel to either of the sides as Gg, the side Ag will be to AE, as Ag to Ae, or as Gg to Ee.

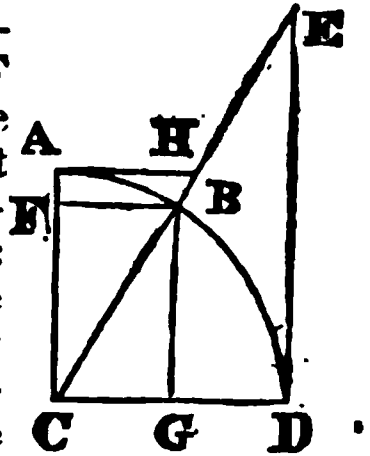
To demonstrate this, upon the line AG take the line AB so that a certain multiple of it may be equal to AE, and another multiple of it may be equal to AG; this may be always done accurately when AE and AG are commensurable; if they are not accurately commensurable, the quantity AB may be taken so small that certain multiples of it may differ from AE and AG respectively by quantities less than any assignable. On the line AG, take BC, CD, DE, EF, FG, &c. each equal to AB, and through these points draw the lines Bb, Cc, &c. parallel to Gg, cutting the line Ag in the points b, c, d, e, &c. draw also the lines BM, CL, DK, &c. parallel to Ag, cutting the former parallels in the points N, O, P, &c. and the line Gg in the points M, L, K, &c. Then the triangles ABb, BCN, CDO, &c. are similar and equal to each other: for the lines Bb, CN are parallel, therefore the angle ABb = BCN (by art. 31) and



therefore since in the two triangles CDF, cdf, the two angles FCD, CDF of the one, are equal to the two angles fcd, cdf, of the other, each to each, the remaining angle CFD is also equal to the remaining angle cfd, (*by art. 36*;) consequently the triangles CFD, cfd, are similar. The triangles BCD, bcd are also similar, for the angle CBD is equal to the angle CDB, being each subtended by the radius; therefore (*by art. 36*) each of these angles is equal to half the supplement of the angle BCD; and in the same manner the angle cbd or cdb is equal to half the supplement of the angle bcd, and since the angle BCD is equal to bcd, the angles of these two triangles must be equal, consequently they are similar. The triangles BCE, bce are also similar, because BE is parallel to FD, and be parallel to fd. Hence we obtain (*by art. 54*) the following analogies. $CD : cd :: FD : fd$; $CD : cd :: BD : bd$; $CB : cb :: BE : be$, &c.

LVI.

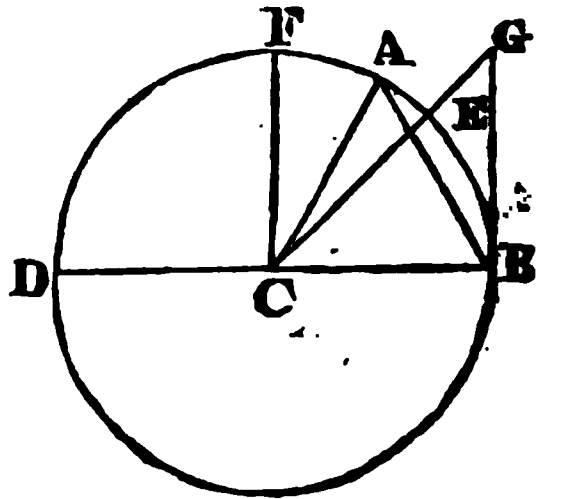
Let ABD be a quadrant of a circle, described by the radius CD, BD any arch of it, BA its complement, BG or CF the sine, CG or BF the co-sine, DE the tangent, AH the co-tangent, CE the secant, and CH the co-secant of that arch BD. Then since the triangles CDE, CGB, are similar or equi-angular we shall have (*by art. 54*) $DE : CE :: BG : CB$, that is, the tangent of an arch, is to secant of the same, as the sine of it is to radius. Also, $CE : CD :: CB : CG$; that is, the secant is to radius as the radius to the co-sine of an arch. Also, $CF : CA :: CB : CH$, that is, the sine is to radius as radius to the co-secant of an arch; and since the triangle CAH is similar to the triangle CDE, we have $AH : CA :: CD : DE$, that is, the co-tangent is to the radius as the radius to the tangent of an arch.



LVII.

In all circles, the sine of 90° , the tangent of 45° , and the chord of 60° , are each equal to the radius.

For in the circle DFAEB, let the arch BE be 45° , the arch BA 60° , and BF 90° . Draw through the centre C the diameter DCB and perpendicular thereto the tangent BG meeting CE produced in G; draw the chord BA, and join CF, CA.—Then since the arch BF is 90° , DF must be 90° , whence (*by art. 12 & 19*) the radius CF is equal to the sine of the arch BF, or sine of 90° . Again, in the triangle CBG, since the angle CBG is 90° , and BCG is 45° by supposition, the angle CGB is also 45° (*by art. 36*) therefore (*by art. 39*) BG is equal to CB, that is, the tangent of 45° is equal to the radius. Again, the angle ACB is 60° (being measured by the arch BA) and the angle CBA is also 60° (being measured by half the arch AD = 120° by art. 40) therefore (*by art. 39*) $CA = AB$, that is, the chord of 60° is equal to the radius.

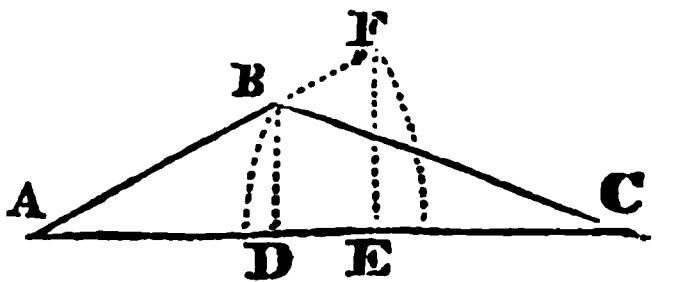


The four following propositions contain the demonstration of the rules by which all the calculations of trigonometry may be made; they were inserted here in order to prevent any embarrassment of the young calculator, from the introduction of the demonstrations among the precepts for calculation.

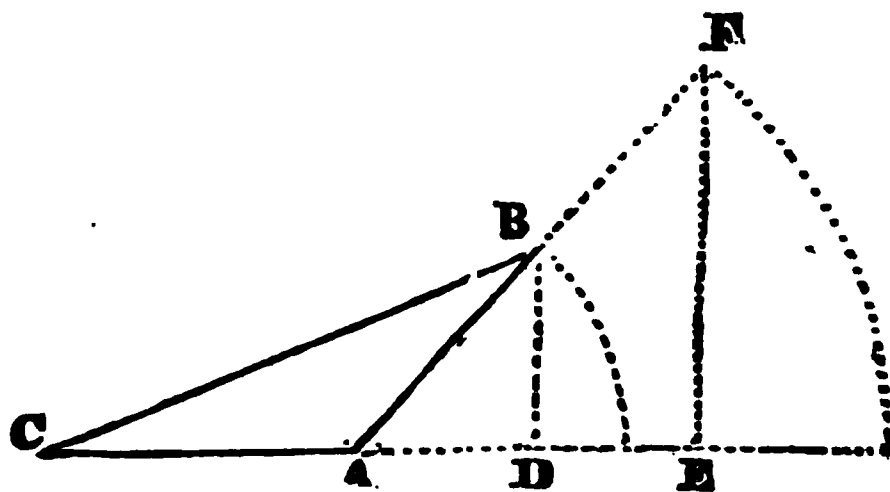
LVIII.

In any plane triangle, the sides are proportional to the sines of the opposite angles.

Let ABC be the triangle; produce the lesser side AB to F, making AF equal to BC; from B and F let fall the perpendiculars BD, FE, upon AC (produced if necessary;) then FE is the sine of the angle A, and BD is the sine of the angle C, the



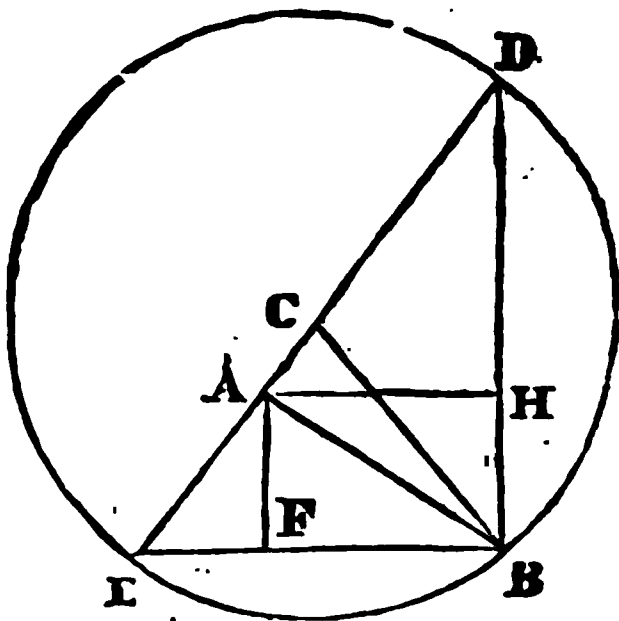
radius being BC equal to AF ; now the triangles ABD , AFE , having the angle A common to both, and the angle D equal to the angle E (being each equal to a right angle) are similar; hence (*by art. 54*) as AF (or its equal BC) is to AB , so is FE to BD ; that is, BC is to AB as the sine of the angle A is to the sine of the angle C .



LIX.

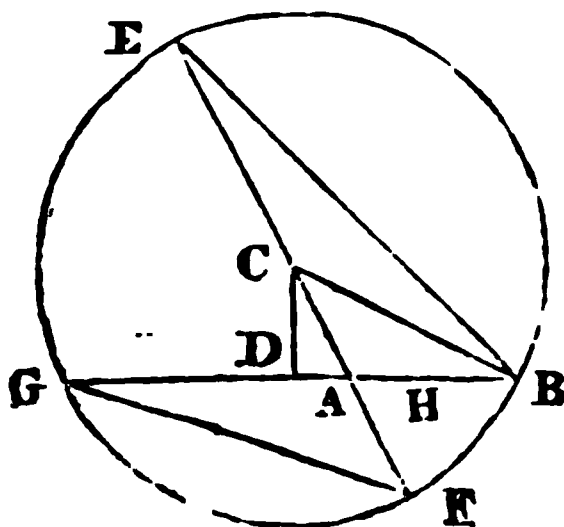
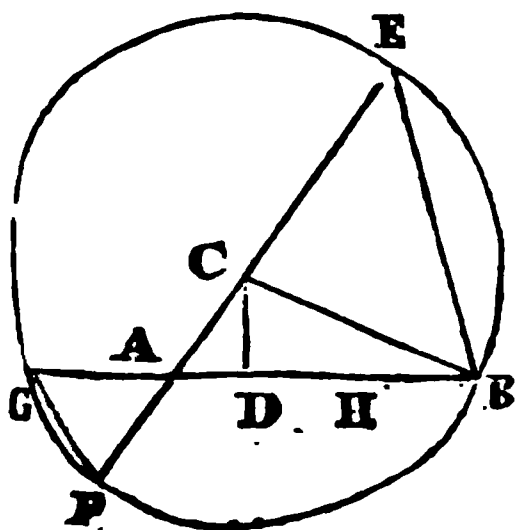
In any triangle (supposing any side to be the base, and calling the other two the sides) the sum of the sides is to their difference, as the tangent of half the sum of the angles at the base is to the tangent of half the difference of the same angles.

Thus, in the triangle ABC , if we call AB the base, it will be as the sum of AC and CB is to their difference, so is the tangent of half the sum of the angles ABC , BAC , to the tangent of half their difference.



Dem. With the longest leg CB as radius, describe a circle about the centre C ; meeting the shorter side AC (produced on each side) in the points D and E , join EB , DB ; draw AH perpendicular to DB , and AF perpendicular to EB ; then (*by art. 42*) the angle EBD , being in a semi-circle, is a right angle; and the triangles AHD , AFE , are similar, and AF is equal to HB . Moreover, since CB is equal to CD or CE , AD is the sum and AE is the difference of the legs AC , CB ; likewise (*by art. 33*) the angle BCD is equal to the sum of the angles BAC , ABC , and therefore (*by art. 40*) the angle DEB , or its equal DAH , is equal to half the sum of the angles at the base ABC , BAC . Again (*by art. 33*) the angle BAC is equal to the sum of the angles CEB (or CBE) and ABE , and therefore is equal to the sum of the angle ABC , and twice the angle ABE ; hence the angle ABE or its equal BAH , is equal to half the difference of the angles at the base. But in the right angled triangles AHD , AHB , making AH radius, the legs DH , HB are the tangents of the angles DAH , BAH , or the tangents of half the sum and half the difference of the angles at the base; but by reason of the similar triangles AHD , AFE , we have $AD : AE :: DH : AF$ or HB ; that is, AD , the sum of the legs AC and CB , is to AE their difference, as DH the tangent of half the sum of the angles at the base (the radius being AH) is to HB the tangent of half the difference of the same angles, (to the same radius,) and therefore (*by art. 55*) as the tabular tangent of half the sum of the angles at the base is to the tabular tangent of half the difference of the same angles.

LX.



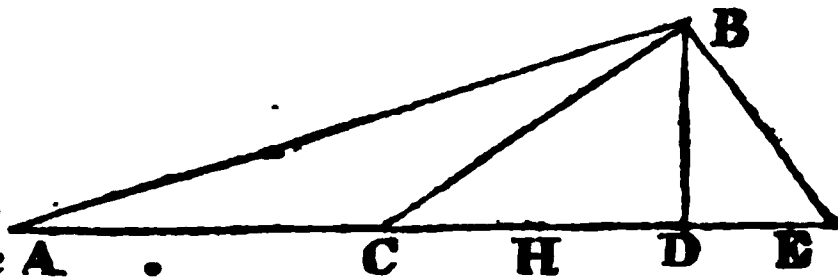
In any plane triangle ABC , if the line CD be drawn perpendicular to the base AB , dividing it into two segments, AD , DB , and the base AB be bisected in the point H , we shall have,

As the base AB is to the sum of the sides, AC , BC , so is the difference of the sides to twice the distance DH of the perpendicular from the middle of the base.

Dem. With the greater side CB as radius, describe about the centre C the circle $BFGE$, meeting the other side produced in the points E and F , and the base AB produced in G ; join GF and BE . Then AE is the sum, and AF the difference of the sides AC , CB ; and since CD is perpendicular to GB , the line GB is bisected in D (by art. 43) and as AB is bisected in H , the line AG is equal to twice DH . Now in the triangles BAE , GAF , the angles ABE , GFA are equal (by art. 41) and the angle BAE is equal to GAF (by art. 28) therefore the remaining angles AEB , AGF , are equal, and the triangles BAE , GAF , are similar; consequently (by art. 54) $AB : AE :: AF : AG$, or twice HD , which is the proposition to be demonstrated. Having thus obtained HD , we may find the segments AD , DB , by adding HD to the half base HA or HB and by taking their difference.

LXI.

In any plane triangle, the square of radius is to the square of the co-sine of half of either of the angles, as the rectangle contained by the two sides including that angle is to the rectangle contained by the half sum of the sides, and that half sum decreased by the side opposite to that angle.



Thus in the triangle CBE , the square of radius is to the square of the co-sine of half the angle C , as the rectangle $CB \times CE$ is to $\frac{CB+CE+BE}{2} \times \frac{CB+CE-BE}{2}$.

For continue EC to A , making $CA=CB$, draw BD perpendicular to CE , bisect CE in H , and join AB . Then (supposing CB to be greater than EB) we

have (by art. 60) $CE : CB+BE :: CB-BE : \frac{CB^2-BE^2}{CE} = 2.HD$; by adding

half this to half the base $=CH$, we have the segment $CD = \frac{CB^2-BE^2+CE^2}{2.CE}$

to this adding CA or CB , we have $AD = \frac{CB^2-BE^2+CE^2+2.CE.CB}{2.CE} =$

$\frac{CB+CE+BE}{2.CE} = \frac{CB+CE+BE \times CB+CE-BE}{2.CE}$ Again, $AD=AC+CD=CB+CD$;

hence $AD^2=CB^2+2CB.CD+CD^2$; also, $BD^2=CB^2-CD^2$; hence $AB^2=$

$AD^2+BD^2=2CB^2+2CB.CD=2CB \times CB+CD=2CB . AD$; hence $AB^2 : AD^2 ::$

$2CB : AD = \frac{CB+CE+BE}{2.CE} . \frac{CB+CE-BE}{2.CE}$; but AB being radius, AD is the co-sine

of the angle A , which is equal to half the angle C (by art. 40;) therefore the square of radius is to square of the co-sine of half the angle C , as the rectangle $CE.CB$ is

to the rectangle $\frac{CB+CE+BE}{2} \times \frac{CB+CE-BE}{2}$

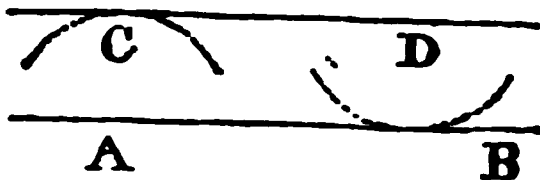
The other cases of this proposition may be demonstrated in the same manner.

GEOMETRICAL PROBLEMS.

PROBLEM I.

To draw a Right Line CD parallel to a given Right Line AB, at any given distance, as at the point D.

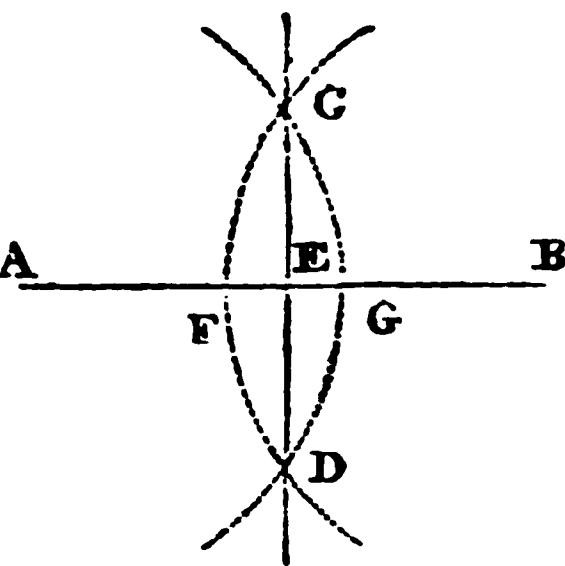
With a pair of compasses take the nearest distance between the point D and the given right line AB; with that distance set one foot of the compasses any where on the line AB, as at A, and draw the arch C on the same side of the line AB as the point D, from the point D draw a line so as just to touch the arch C, and it is done; for the line CD will be parallel to the line AB, and at the distance of the point given D, as was required.



PROBLEM II.

To bisect or divide a given line AB into two equal parts.

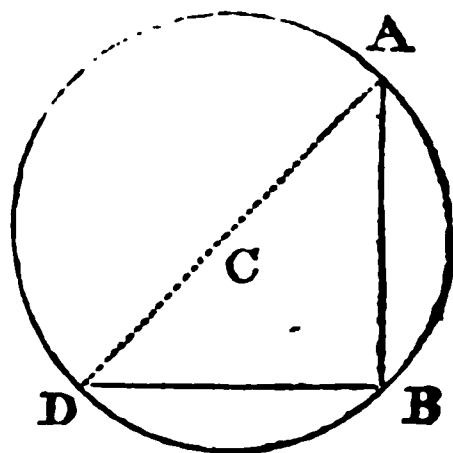
Take any distance in your compasses greater than half the line AB, then with one foot in B, describe the arch CFD; with the same distance, and one foot in A, describe the arch CGD, cutting the former arch in C and D; draw the line CD, and it will bisect AB in the point E.



PROBLEM III.

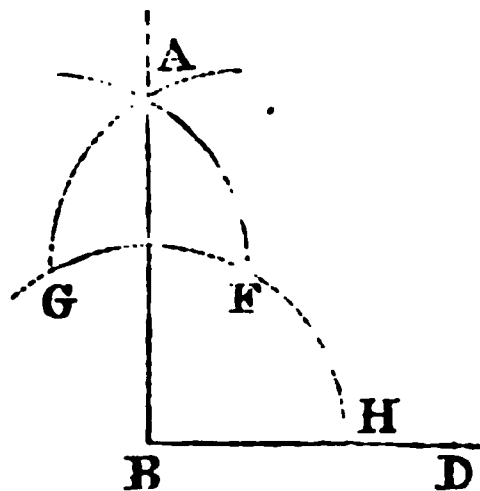
To erect a perpendicular BA on the end of a given Right Line DB.

Take any extent in your compasses, and with one foot in B fix the other in any point C without the given line; then with one point of the compasses in C, describe with the other the circle ABD; through D and C draw the diameter DCA meeting the circle in A; join B and A and it is done; for BA will be the required line (by art. 42 Geom.)



Or thus,

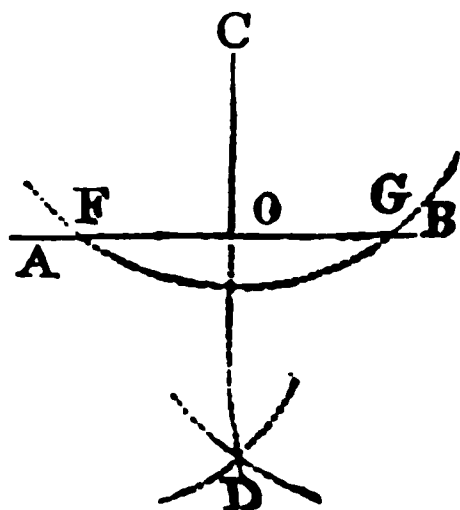
Take any convenient distance as BH in your compasses, and with one foot in B describe the arch HFG, upon which set off the same distance as a chord from H to F, and from F to G, upon F and G describe two arches intersecting each other in A; draw a line from B to A and it is done; for BA will be the perpendicular required.



PROBLEM IV.

From a given point as C, to let fall a perpendicular CO, on a given Right Line AB.

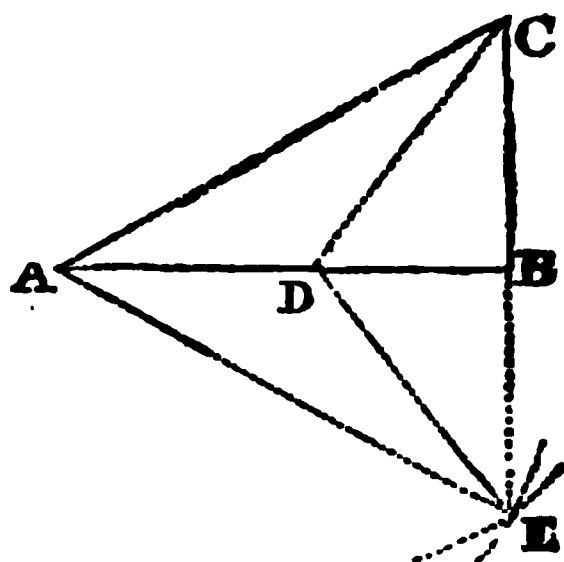
Take any extent in your compasses greater than the least distance between C and the given line AB; with one foot in C, describe an arch to cut the given line AB in F and G;—with one foot in G describe an arch, and with the same distance, and one foot in F, describe another arch cutting the former in D; from C to D draw the line COD, cutting AB in O; then CO will be the perpendicular required.



PROBLEM V.

From a given point C to let fall a perpendicular CB on a given Line AB, when the perpendicular is to fall so near the end of the given line that it cannot be done as above.

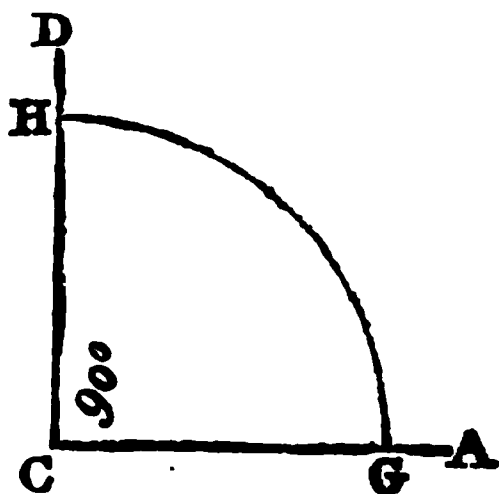
Upon any point A of the line AB as a centre, and with the distance AC describe an arch E; choose any other point in the line AB, as D, and with the distance DC describe another arch intersecting the former in E, join CE cutting AB in B, and it is done, for CB will be the perpendicular required.

**PROBLEM VI.**

To make an angle that shall contain any proposed number of degrees, from a given point in a given line.

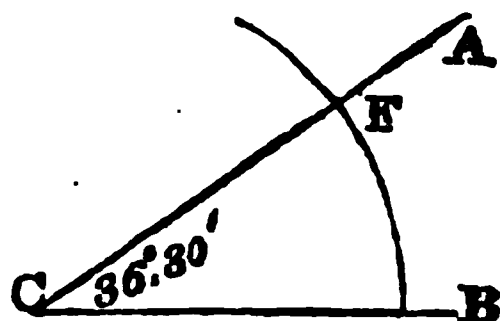
CASE 1. When the given angle is right, or contains 90° let CA be the given line, and C the given point.

On C erect a perpendicular CD, and it is done; for the angle DCA is an angle of 90° . Or thus, on the point C as a centre, with the chord of 60° * describe an arch GH, and set off thereon from G to H the distance of the chord of 90° and from C through H draw CHD, which will form the angle DCA of 90° required.



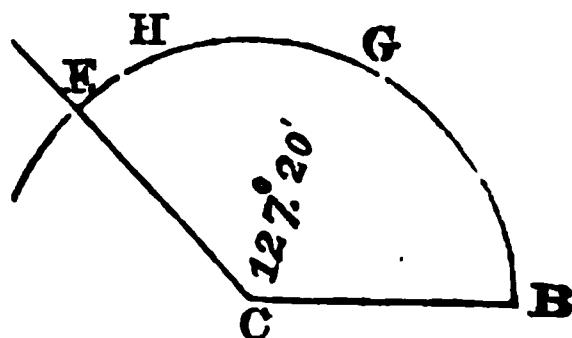
CASE 2. When the angle is acute, as for example $36^\circ 30'$ let CB be the given line and C the point at which the angle is to be made.

With the chord of 60° in your compasses, and one foot on C, as a centre, draw the arch FB, on which set off from B to F, the given angle $36\frac{1}{2}^\circ$ taken from the line of chords; through F and the centre C draw the right line AC, and it is done; for the angle ACB will be an angle of $36^\circ 30'$ as was required.



CASE 3. When the given angle is obtuse, as for example $127^\circ 20'$ let CB be the given line and C the angular point.

Take the chord of 60° in your compasses, and with one foot on C as a centre, describe an arch BGHE, upon which set off the chord of 60° (which you already have in your compasses) from B to G, and from G to H; then set off from G to E, the excess of the given angle above 60° , which is $67\frac{1}{2}^\circ$ taken from the line of chords; or you may set off from H to E, the excess of the given angle above 120° , which is $7\frac{1}{2}^\circ$; draw the line CE, and it is done, for the angle ECB will be an angle of $127^\circ 20'$.

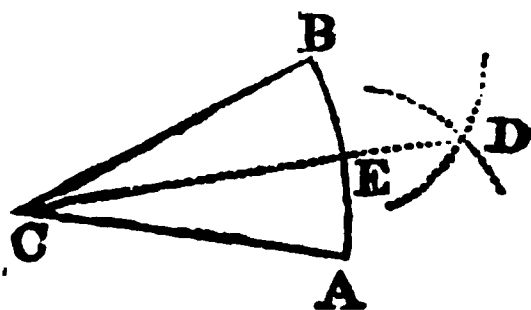


Were it required to measure a given angle, the process would have been nearly the same, by sweeping an arch as BE, and measuring it on the line of chords, as is evident.

PROBLEM VII.

To bisect a given arch of a circle AB, whose centre is C.

Take in your compasses any extent greater than the half of AB, and with one foot in A, describe an arch; with the same extent and one foot in B, describe another arch cutting the former in D; join CD and it is done, for this line will bisect the arch AB in the point E. It is also evident that the line CD bisects the angle BCA, or divides it into two equal parts.

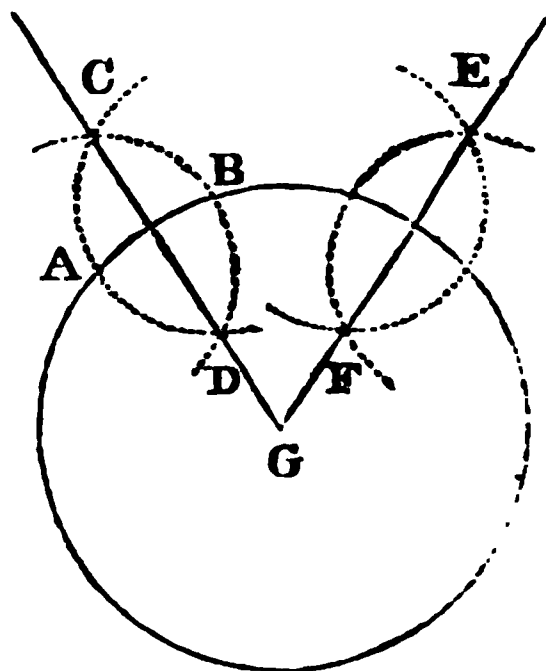


* For a description of the line of Chords see page 20.

PROBLEM VIII.

To find the centre of a given Circle.

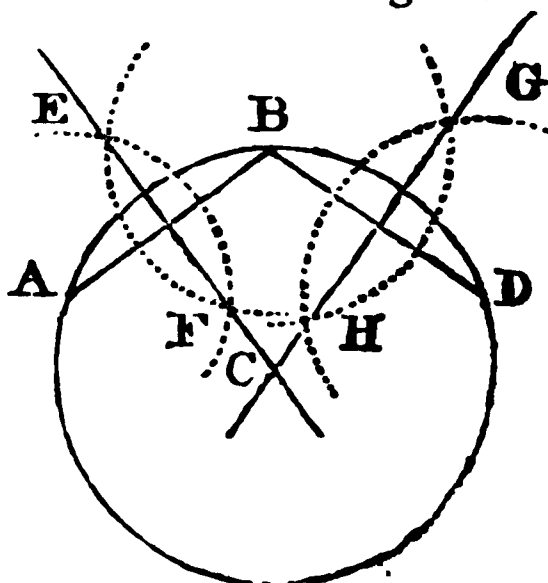
With any radius, and one foot in the circumference as at A, describe an arch of a circle, as CBD, cutting the given circle in B; with the same extent, and one foot in B, describe another arch CAD, cutting the former in C and D; through C and D draw the line CD, which will pass through the centre of the circle; in like manner may another right line be drawn, as EFG, which shall cross the first right line at the centre required. This construction depends upon article 43 of Geometry.



PROBLEM IX.

To draw a Circle through any three given points not situated in a Right Line.

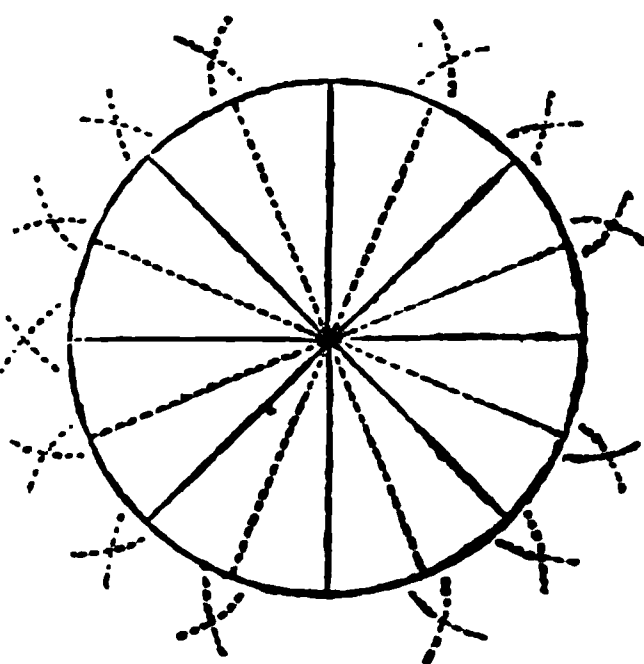
Let A, B and D be the given points. Take in your compasses any distance greater than half AB, and with one foot in A describe an arch EF; with the same extent, and one foot in B, describe another arch cutting the former in the points E, F, through which draw the indefinite right line EFC; then take in your compasses any extent greater than half BD, and with one foot in B, describe an arch GH; with the same extent, and one foot in D, describe another arch cutting the former in the points G, H, through which draw the right line GHC, cutting the former right line EFC, in the point C; upon the point C as a centre, with an extent equal to CA, CB, or CD, as radius, describe the sought circle.



PROBLEM X.

To divide a Circle into 2, 4, 8, 16, or 32, equal parts.

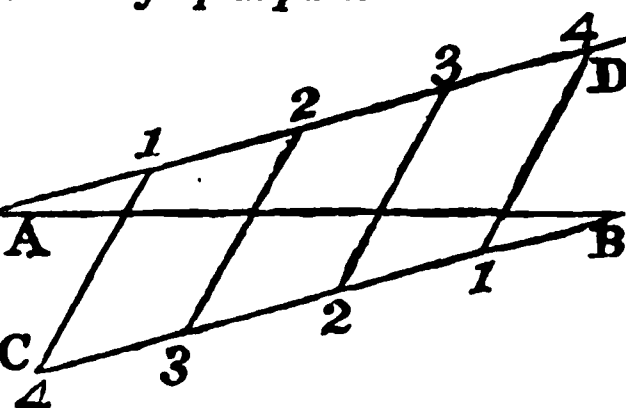
Draw a diameter through the centre, dividing the circle into two equal parts; bisect this diameter by another drawn perpendicular thereto, and the circle will be divided into four equal parts or quadrants; bisect each of these quadrants again by right lines drawn through the centre, and the circle will be divided into eight equal parts; and so you may continue the bisections any number of times. This problem is useful in constructing the mariner's compass.



PROBLEM XI.

To divide a given Line into any number of equal parts.

Let it be required to divide the line AB into five equal parts.—From the point A draw any line AD, making an angle with the line AB; then through the point B draw a line BC parallel to AD; and from A, with any small opening in your compasses, set off a number of equal parts on the line AD, less by one than the proposed number (which number of equal parts in this example is 4:) then from B set off the same number of the same parts on the line BC, then join 4 and 1, 3 and 2, 2 and 3, 1 and 4, and these lines will cut the given line as required.



CONSTRUCTION OF THE PLANE SCALE.

1st. WITH the radius you intend for your scale, describe a semicircle ADB, (Plate II. fig. 1.) and from the centre C draw CD perpendicular to AB, which will divide the semicircle into two quadrants, AD, BD; continue CD towards S, draw BT perpendicular to CB, and join BD and AD.

2dly. Divide the quadrant BD into 9 equal parts, then will each of these be 10 degrees; subdivide each of these parts into single degrees, and if your radius will admit of it, into minutes or some aliquot parts of a degree greater than minutes.

3dly. Set one foot of the compasses in B and transfer each of the divisions of the quadrant BD to the right line BD, then will BD be a line of chords.

4thly. From the points 10, 20, 30, &c. in the quadrant BD draw right lines parallel to CD, to cut the radius CB, and they will divide that line into a line of sines which must be numbered from C towards B.

5thly. If the same line of sines be numbered from B towards C, it will become a line of versed sines, which may be continued to 180° , if the same divisions be transferred on the same line on the other side of the centre C.

6thly. From the centre C, through the several divisions of the quadrant BD, draw right lines till they cut the tangent BT, so will the line BT become a line of tangents.

7thly. Setting one foot of the compasses in C, extend the other to the several divisions 10, 20, 30, &c. in the tangent line BT, and transfer these extents severally to the right line CS, then will that line be a line of secants.

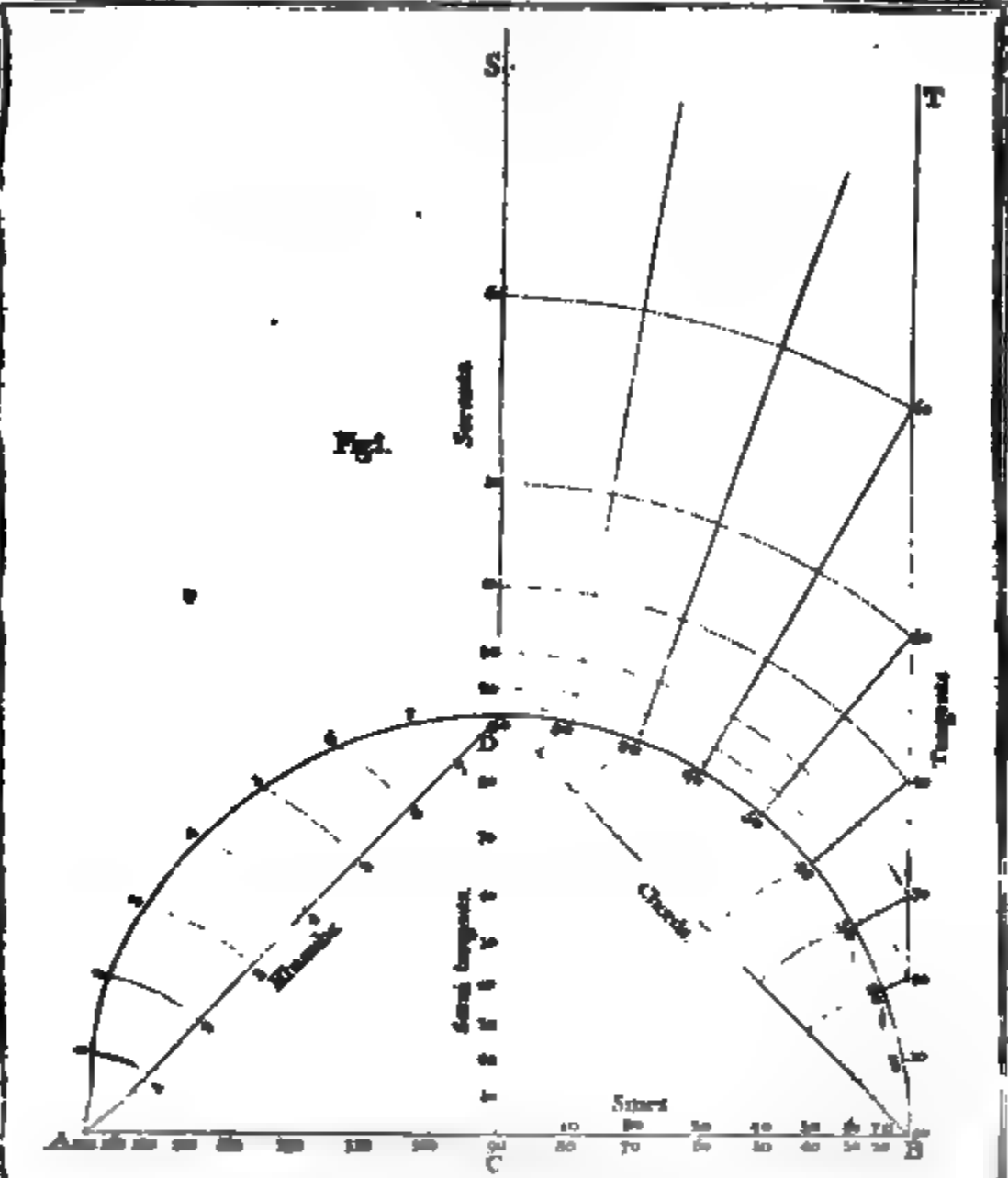
8thly. Right lines drawn from A to the several divisions 10, 20, 30, &c. in the quadrant BD, will divide the radius CD into a line of semi-tangents.

9thly. Divide the quadrant AD into eight equal parts, and from A as a centre transfer these divisions severally into the line AD, then will AD be a line of Rhumbs, each division answering to $11^\circ 15'$ upon the line of chords. The use of this line is for protracting and measuring angles, according to the common division of the mariner's compass. If the radius AC be divided into 100 or 1000, &c. equal parts, and the lengths of the several sines, tangents, and secants, corresponding to the several arches of the quadrant, be measured thereby, and these numbers be set down in a table,* each in its proper column, you will by these means have a collection of numbers by which the several cases in trigonometry may be solved. Right lines graduated as above, being placed severally upon a ruler, form the instrument called the Plane Scale, (see Plate II. fig. 2.) by which the lines and angles of all triangles may be measured. All right lines, as the sides of plain triangles, &c. when they are considered simply as such without having any relation to a circle, are measured by scales of equal parts, one of which is subdivided equally into 10, and this serves as a common division to all the rest. In most scales an inch is taken for a common measure, and what an inch is divided into is generally set at the end of the scale. By any common scale of equal parts, divided in this manner, any number less than 100 may be readily taken; but if the number should consist of three places of figures, the value of the third figure cannot be exactly ascertained, and in this case it is better to use a diagonal scale, by which any number consisting of three places of figures, may be exactly found. The figure of this scale is given in Plate II. fig. 3: its construction is as follows.

Having prepared a ruler of convenient breadth for your scale, draw near the edges thereof two right lines, *af*, *cg*, parallel to each other; divide one of these lines as *af*, into equal parts, according to the size of your scale;† and

* In table XXIV. is given the sine and co-sine to every minute of the quadrant, to five places of decimals.

† The length of one of these equal parts at the end of the scale to which this description refers is *ab* or *cd*. The length of one of the equal parts of the scale of the other end being the half of *ab*.



Plane Scale Fig. 2

Plane	1	2	3	4	5	6	7	8
Choc	10	20	30	40	50	60	70	80
Star	10	20	30	40	50	60	70	80
Trans	10	20	30	40	50	60	70	80
S.T.	10	20	30	40	50	60	70	80

Diagonal Scale Fig. 3

Diagonal	1	2	3	4	5	6	7	8
Choc	10	20	30	40	50	60	70	80
Star	10	20	30	40	50	60	70	80
Trans	10	20	30	40	50	60	70	80
S.T.	10	20	30	40	50	60	70	80

through each of these divisions draw right lines perpendicular to *af*, to meet *cg*, then divide the breadth into 10 equal parts, and through each of these divisions draw right lines parallel to *af* and *cg*; divide the lines *ab*, *cd*, into 10 equal parts, and from the point *a* to the first division in the line *cd*, draw a diagonal line: then parallel to that line, draw diagonal lines through all the other divisions, and the scale is complete. Then, if any number, consisting of three places of figures, as 256, be required from the larger scale *gd*, you must place one foot of the compasses on the figure 2 on the line *gd*, then the extent from 2 to the point *d* will represent 200. The second figure being 5, count five of the smaller divisions from *d* towards *e*, and the extent from 2 to that point will be 250. Move both points of the compasses downwards till they are on the sixth parallel line below *gd*, and open them a little till the one point rests on the vertical line drawn through 2, and the other on the diagonal line drawn through 5; the extent then in the compasses will represent 256. In the same way the quantities 25,6; 2,56; 0,256, &c. are measured.

Besides the lines already mentioned, there is another on the Plane Scale marked *ML*, which is joined to a line of chords, and shows how many miles of easting or westing correspond to a degree of longitude in every latitude.* These several lines are generally put on one side of a ruler, two feet long; and on the other side is laid down a scale of the logarithms of the sines, tangents, and numbers, which is commonly called Gunter's Scale, and as it is of general use, it requires a particular description.



GUNTER'S SCALE.

ON GUNTER'S SCALE are eight lines, viz.

1st. Sine Rhumbs. marked (SR) corresponding to the logarithms† of the natural sines of every point of the mariner's compass, numbered from the left hand towards the right, with 1, 2, 3, 4, 5, 6, 7, to 8, where is a brass pin. This line is also divided, where it can be done, into halves and quarters.

2d. Tangent rhumbs. marked (TR) correspond to the logarithms of the tangents of every point of the compass, and are numbered 1, 2, 3, to 4, at the right hand where there is a pin, and thence towards the left hand with 5, 6, 7: it is also divided, where it can be done, into halves and quarters.

3d. The line of numbers, marked (Num.) corresponds to the logarithms of numbers, and is marked thus: near the left hand it begins at 1, and towards the right hand are 2, 3, 4, 5, 6, 7, 8, 9; and 1 in the middle, at which is a brass pin, then 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the end, where there is another pin. The values of these numbers and their intermediate divisions depend on the estimated values of the extreme numbers 1 and 10; and as this line is of great importance, a particular description of it will be given. The first 1 may be counted for 1, 10, 100, or 1000, &c. and then the next 2, will be 2, 20, 200, or 2000, &c. respectively. Again, the first 1 may be reckoned 1 tenth, 1 hundredth, or 1 thousandth part, &c. then the next will be 2 tenths, or 2 hundredths, or 2 thousandths parts, &c. so that if the first 1 be esteemed 1, the middle 1 will be 10; 2 to its right 20; 3, 30; 4, 40; and 10 at the end 100; again, if the first 1 is 10, the next 2 is 20, 3 is 30, and so on, making the middle 1, 100, the next 2 is 200, 3 is 300, 4 is 400, and 10 at the end is 1000. In like manner, if the first 1 be esteemed 1 tenth part, the next 2 will be 2

* As it would confuse the adjoined figure to describe on it the line of longitudes, it is neglected, but the construction is as follows: divide the line CB into 60 equal parts (if it can be done) and through each point draw lines parallel to CD to intersect the arch BD: about B, as a centre, transfer the several points of intersection to the line BD, and then number it from D, towards B, from 0 to 60, and it will be the line of longitudes.

† The description and use of logarithms are given in page 29, et seq. The log-sines, tangents, &c. are marked on these scales by means of a line of equal parts, corresponding to the size of the scale.

tenth parts, and the middle 1 will be 1 ; the next 2. 2 ; and 10 at the end will be 10. Again, if the first 1 be counted 1 hundredth part, the next 2 hundredth parts, the middle 1 will be 10 hundredth parts, or one tenth part, and the next 2 two tenth parts, and 10 at the end will be but one whole number or integer.

As the figures are increased or diminished in their value, so in like manner must all the intermediate strokes or subdivisions be increased or diminished : that is, if the first 1 at the left hand be counted 1, then 2 (next following it) will be 2, and each subdivision between them will be 1 tenth part, and so all the way to the middle 1, which will be 10, the next 2, 20, and the longer strokes between 1 and 2 are to be counted from 1 thus, 11, 12, (where is a brass pin) then 13, 14, 15, sometimes a longer stroke than the rest, then 16, 17, 18, 19, 20, at the figure 2 ; and in the same manner the short strokes between the figures 2 and 3, 3 and 4, 4 and 5, &c. are to be reckoned as units. Again, if 1 at the left hand be 10, the figures between it and the middle 1 will be common tens ; and the subdivisions between each figure will be units ; from the middle 1 to 10 at the end, each figure will be so many hundreds ; and between these figures each longer division will be 10. From this description it will be easy to find the divisions representing any given number, thus : Suppose the point representing the number 12, were required ; take the division at the figure 1 in the middle, for the first figure of 12 ; then for the second figure count two tenths, or longer strokes to the right hand, and this will be the point representing 12, where the brass pin is.

Again, suppose the number 22 were required ; the first figure 2 is to be found on the scale, and for the second figure 2, count 2 tenths onwards, and that is the point representing 22.

Again, suppose 1728 were required ; for the first figure 1, I take the middle 1, for the second figure 7, count onwards as before, and that will be 1700. And as the remaining figures are 28 or nearly 30, I note the point which is nearly $\frac{3}{8}$, of the distance between the marks 7 and 8, and this will be the point representing 1728.

If the point representing 435 was required ; from the 4 in the second interval count towards 5 on the right, three of the larger divisions and one of the smaller (this smaller division being midway between the marks 3 and 4) and that will be the division expressing 435. In a similar manner other numbers may be found.

All fractions found in this line must be decimals ; and if they are not, they must be reduced into decimals, which is easily done by extending the compasses from the denominator to the numerator ; that extent laid the same way, from 1 in the middle or right hand, will reach to the decimal required.

EXAMPLE. Required the decimal fraction equal to $\frac{3}{4}$: Extend from 4 to 3 ; that extent will reach from 1 on the middle to .75 towards the left hand. The like may be observed of any other vulgar fraction.

Multiplication is performed on this line, by extending from 1 to the multiplier : that extent will reach from the multiplicand to the product.

Suppose, for example, it were required to find the product of 16 multiplied by 4, extend from 1 to 4 ; that extent will reach from 16 to 64, the product required.

Division being the reverse of multiplication, therefore extend from the divisor to unity ; that extent will reach from the dividend to the quotient.

Suppose 64 to be divided by 4 ; extend from 4 to 1, that extent will reach from 64 to 16, the quotient.

Questions in the Rule of Three are solved by this line as follows : Extend from the first term to the second, that extent will reach from the third term* to the fourth. And it ought to be particularly noted, that if you extend to the left, from the first number to the second, you must also extend to the left, from the third number to the fourth ; and the contrary.

* Or you may extend from the first to the third, for that extent will reach from the second to the fourth. This method must be adopted when using the lines of sines, tangents, &c. if the first and third terms are of the same name, and different from the second and fourth.

DESCRIPTION AND USE OF GUNTER'S SCALE. 23

EXAMPLE. If the diameter of a circle be 7 inches, and the circumference 22, what is the circumference of another circle, the diameter of which is 14 inches? Extend from 7 to 22, that extent will reach from 14 to 44 the same way.

The superficial content of any parallelogram is found by extending from 1 to the breadth; that extent will reach from the length to the superficial content.

EXAMPLE. Suppose a plank or board, 15 inches broad and 27 feet long, the content of which is required: Extend from 1 to 1 foot 3 inches (or 1,25;) that extent will reach from 27 feet to 33,75 feet, the superficial content. Or extend from 12 inches to 15, &c.

The solid content of any bale, box, chest, &c, is found by extending from 1 to the breadth; that extent will reach from the depth to a fourth number, and the extent from 1 to that fourth number will reach from the length to the solid content.

EXAMPLE 1st. What is the content of a square pillar, whose length is 21 feet 9 inches, and breadth 1 foot 3 inches? The extent from 1 to 1,25 will reach from 1,25 to 1,56, the content of one foot in length; again, the extent from 1 to 1,56 will reach from the length 21,75 to 33,9, or 34, the solid content in feet.

EXAMPLE 2d. Suppose a square piece of timber, 1,25 feet broad, ,56 deep, and 36 long, be given to find the content: extend from 1 to 1,25; that extent will reach from ,56 to ,7; then extend from 1 to ,7; that extent will reach from 36 to 25,2 the solid content. In like manner may the contents of bales, &c. be found, which divided by 40 will give the tonnage.

4thly. The line of sines marked (Sin.) corresponding to the log-sines of the degrees of the quadrant, begins at the left hand, and is numbered to the right thus: 1, 2, 3, 4, 5, &c. to 10; then 20, 30, 40, &c. ending at 90 degrees, where is a brass centre pin, as there is at the right end of all the lines.

5thly. The line of versed sines, marked (V. S.) corresponding to the log versed sines of the degrees of the quadrant, begins at the right hand against 90° on the sines, and from thence is numbered towards the left hand thus: 10, 20, 30, 40, &c. ending at the left hand at about 169° ; each of the subdivisions, from 10 to 30, is in general two degrees, from thence to 90 is single degrees, from thence to the end, each degree is divided into 15 minutes.

6thly. The line of tangents, marked (Tang.) corresponding to the log-tangents of the degrees of the quadrant, begins at the left hand, and is numbered towards the right thus: 1, 2, 3, &c. to 10, and so on 20, 30, 40, and 45, where is a brass pin under 90° on the sines; from thence it is numbered backwards, 50, 60, 70, 80, &c. to 89, ending at the left hand where it began at 1 degree. The subdivisions are nearly similar to those of the sines. When you have any extent in your compasses, to be set off from any number less than 45° on the line of tangents, towards the right, and it is found to reach beyond the mark of 45° , you must see how far it extends beyond that mark, and set it off from 45° towards the left, and see what degree it falls upon, which will be the number sought, which must exceed 45° ; if, on the contrary, you are to set off such a distance to the right from a number greater than 45° , you must proceed as before, only remembering, that the answer must be less than 45° , and you must always consider the degrees above 45° as if they were marked on the continuation of the line to the right hand of 45° .

7thly. The line of the meridional parts, marked (Mer.) begins at the right hand, and is numbered thus; 10, 20, 30, &c. to the left hand, where it ends at 27 degrees. This line, with the line of equal parts, marked (E. P.) under it, are used together, and only in Mercator's Sailing. The upper line contains the degrees of the meridian, or latitude in a Mercator's chart, corresponding to the degrees of longitude on the lower line.

The use of this Scale in solving the usual problems of Trigonometry, Plane Sailing, Middle Latitude Sailing, and Mercator's Sailing, will be given in the course of this work; but it will be unnecessary to enter into an explanation of its use in calculating the common problems of Nautical Astronomy, as it is much more accurate to perform those calculations by logarithms.

ON THE SLIDING RULE.

THE Sliding Rule consists of a *fixed part* and a *slider*, and is of the same dimensions, and has the same lines marked on it as on a common Gunter or Plane Scale, which may be used with a pair of compasses in the same manner as those scales; and as a description of those lines has already been given, it will be unnecessary to repeat it here, it being sufficient to observe, that there are two lines of numbers, a line of log-sines and a line of log-tangents on the slider, and that it may be shifted so as to fix any face of it on either side of the fixed part of the scale, according to the nature of the question to be solved.

In solving any problem in Arithmetic, Trigonometry, Plane Sailing, &c. let the proposition be so stated that the first and third terms may be alike, and of course the second and fourth terms alike; then *bring the first term of the analogy on the fixed part, against the second term on the slider, and against the third term on the fixed part will be found the fourth term on the slider*;* or if necessary the first and third terms may be found on the slider, and the second and fourth on the fixed part. Multiplication and Division are performed by this rule, in considering unity as one of the terms of the analogy.

Thus, to perform multiplication, set 1 on the line of numbers of the fixed part against one of the factors on the line of numbers of the slider, then against the other factor on the fixed part will be found the product on the slider.

EXAMPLE. To find the product of 4 by 12 draw out the slider till 1 on the fixed part coincides with 4 on the slider, then opposite 12 on the fixed part will be found 48 on the slider.

To perform Division, set the divisor on the line of numbers of the fixed part against 1 on the slider, then against the dividend, on the fixed part, will be found the quotient on the slider.

EXAMPLE. To divide 48 by 4—set 4 on the fixed part against 1 on the slider, then against 48 on the fixed part will be found 12 on the slider.

EXAMPLES IN THE RULE OF THREE.

If a ship sail 25 miles in 4 hours, how many miles will she sail in 12 hours at the same rate?

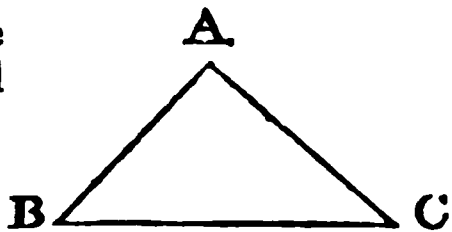
Bring 4 on the line of numbers of the fixed part against 25 on the line of numbers of the slider, then against 12 on the fixed part will be found 75 on the slider, which is the answer required.

EXAMPLE. If 3 pounds of sugar cost 21 cents, what will 27 pounds cost?

Bring 3 on the line of numbers of the fixed part, against 21 on the line of numbers of the slider, then against 27 on the fixed part, will be found 189 on the slider.

EXAMPLE IN TRIGONOMETRY.

In the oblique-angled triangle ABC, let there be given $AB=56$, $AC=64$, angle $ABC=46^{\circ} 30'$ to find the other angles and the side BC.



In this case we have (*by art. 58 Geometry*) the following canons.—

$AC (64) : \text{sine } \angle B (46^{\circ} 30') :: AB (56) : \text{sine } \angle C$, and $\text{sine } \angle B : AC :: \text{sine } \angle A : BC$. Therefore, to work the first proposition by the sliding rule.

* If the first and second terms are alike, instead of the first and third, you must bring the first term on the slider against the third on the fixed part, and against the second term on the slider, will be found the fourth term on the fixed part. Or, if necessary, the first and second terms may be found on the fixed part, and the third and fourth on the slider.

we must bring 64 on the line of numbers of the fixed part, against $46^{\circ} 30'$ on the line of sines of the slider, then against 56 on the former will be $39^{\circ} 24'$ on the latter, which will be the angle C. The sum of the angles B and C being subtracted from 180° leaves the angle $A = 94^{\circ} 6'$. Then, by the second canon, bring the angle $B = 46^{\circ} 30'$ on the line of sines of the slider against $AC = 64$ on the line of numbers of the fixed part, then against the angle $A = 94^{\circ} 6'$ (or its supplement $85^{\circ} 54'$) on the slider will be found the side $BC = 88$ on the fixed part.

In a similar manner may the other propositions in trigonometry be solved.

From what has been said, it will be easy to work all the problems in Plane, Middle Latitude, and Mercator's Sailing, as in the three following examples, which the learner may pass over until he can solve the same problems by the Scale. If any one wishes to know the use of the sliding rule in problems of Spherical Trigonometry, he may consult the treatises written expressly on that subject: but it may be observed, that in such calculations the sliding rule is rather an object of curiosity than of real use, as it is much more accurate to make use of logarithms.

EXAMPLE 1. Given the course sailed 1 point, and the distance 85 miles—required the difference of Latitude and Departure?

By Case 1st of Plane Sailing, we have these canons:

Radius (8 points) : Distance (85) :: Sine Co. Course (7 points) : Diff. Lat.;
and Radius (8 points) : Distance (85) :: Sine Course (1 point) : Departure.

Hence we must bring the radius 8 points on the fixed part of the Sine Rhumbs against 85 on the line of numbers on the slider, then against 7 points on the sine rhumbs will be found the diff. of lat. $83\frac{1}{2}$ on the slider, and against one point will be found the departure $16\frac{1}{2}$ miles.

If the course is given in degrees, you must use the line marked Sin.

EXAMPLE 2. Given the diff. of lat. 40 miles, and departure 30 miles—required the course and distance?

By case 6, of Plane Sailing, we have this canon for the course:—

Diff. Lat. (40) : Radius 45° :: Departure (30) : Tang. Course.

Hence we must bring 40 on the line of numbers of the slider against 45° on the line of tangents on the fixed part, then against 30 on the slider will be found the course 37° nearly.

Again, the canon for the distance gives:

Sine Course (37°) : Departure (30) :: Radius (90°) : Distance.

Hence we must bring 37° on the line of sines of the fixed part against 30 on the line of numbers on the slider, then against 90° on the line of sines of the fixed part will be found the distance 50 on the slider.

EXAMPLE 3. Given the Middle Lat. 40° and the departure 30 miles—required the Diff. of Long.?

By case 6, of Middle Latitude Sailing, we have this canon:—

Sine Comp. Mid. Lat. (50°) : Departure (30) :: Radius (90°) : Diff. Long.

Hence by bringing 50° on the line of sines of the fixed part against 30 on the line of numbers on the slider, then against 90° on the fixed part, we shall find 59 on the slider, which will be the difference of longitude required.

DESCRIPTION AND USE OF THE SECTOR.

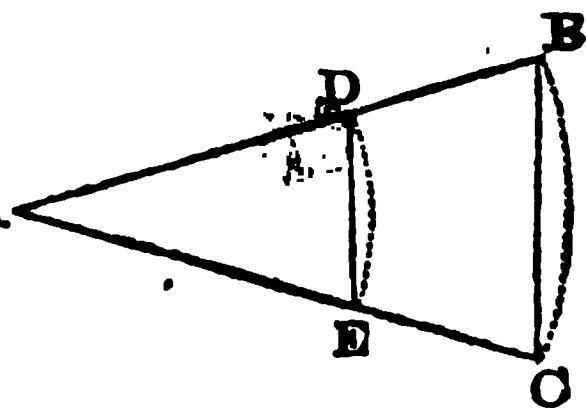
THIS instrument consists of two rules or legs, moveable round an axis or joint, as a centre, having several scales drawn on the faces, some single, others double; the single scales are like those upon a common Gunter's Scale; the double scales are those which proceed from the centre, each being laid twice on the same face of the instrument, viz. once on each leg. From these scales, dimensions or distances are to be taken, when the legs of the instrument are set in an angular position.

The single scales being used exactly like those on the common Gunter's Scale, it is unnecessary to notice them particularly; we shall therefore only enumerate a few of the uses of the double scale, the number of which is seven, viz. the scale of Lines, marked Lin. or L. the scale of chords, marked Cho. or C. the scale of Sines, marked Sin. or S. the scale of Tangents to 45° , and another scale of tangents from 45° to about 76° , both of which are marked Tan. or T. the scale of Secants, marked Sec. or S. and the scale of Polygons, marked Pol.

The scale of lines, chords, sines, and tangents, under 45° , are all of the same radius, beginning at the centre of the instrument, and terminating near the other extremity of each leg, viz. the lines at the division 10, the chords at 60° , the sines at 90° , and the tangents at 45° ; the remainder of the tangents, or those above 45° , are on other scales, beginning at a quarter of the length of the former, counted from the centre, where they are marked with 45° , and extend to about 76 degrees. The secants also begin at the same distance from the centre, where they are marked with 0, and are from thence continued to 75° . The scales of polygons are set near the inner edge of the legs, and where these scales begin, they are marked with 4, and from thence are numbered backward or towards the centre, to 12.

In describing the use of the sector, the terms *lateral distance* and *transverse distance* often occur. By the former is meant the distance taken with the compasses on one of the scales only, beginning at the centre of the sector; and by the latter, the distance taken between any two corresponding divisions of the scales of the same name, the legs of the sector being in an angular position.

The use of the sector depends upon the porportionability of the corresponding sides of similar triangles, (*demonstrated in art. 53, Geometry.*) For if in the triangle ABC we take $AB=AC$ and $AD=AE$, and draw DE, BC, it is evident that DE and BC will be parallel; therefore by the above-mentioned proposition $AB:BC :: AD:DE$; so that whatever part AD is of AB, the same part DE will be of BC; hence, if DE be the chord, sine, or tangent of any arch to the radius AD, BC will be the same to the radius AB.



Use of the line of Lines.

The line of lines is useful to divide a given line into any number of equal parts, or in any proportion, or to find 3d and 4th proportionals, or mean proportionals, or to increase a given line in any proportion.

EXAMPLE 1. To divide a given line into any number of equal parts, as suppose 9: make the length of the given line a transverse distance to 9 and 9, the number of parts proposed; then will the transverse distance of 1 and 1 be one of the parts, or the ninth part of the whole; and the transverse distance of 2 and 2 will be 2 of the equal parts or $\frac{2}{9}$ of the whole line, &c.

EXAMPLE 2. If a ship sails 52 miles in 8 hours, how much would she sail in 5 hours at the same rate?

Take 52 in your compasses as a transverse distance, and set it off from 8 to 8, then the transverse distance 3 and 3 being measured laterally, will be found equal to 19 and a half, which is the number of miles required.

EXAMPLE 3. Having a chart constructed upon a scale of 6 miles to an inch, it is required to open the sector, so that a corresponding scale may be taken from the line of lines?

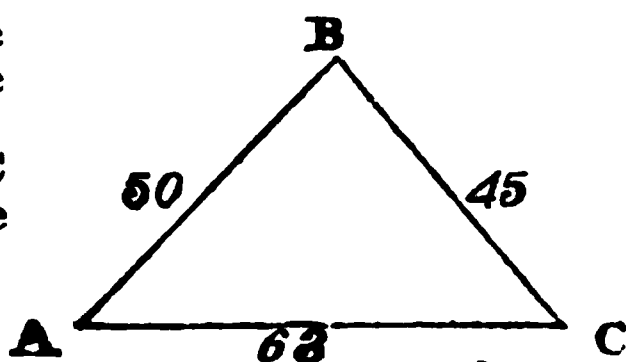
Make the transverse distance 6 and 6, equal to 1 inch, and this position of the sector will produce the given scale.

EXAMPLE 4. It is required to reduce a scale of 6 inches to a degree, to another of 3 inches to a degree?

Make the transverse distance 6 and 6, equal to the lateral distance 3 and 3: then set off any distance from the chart laterally, and the corresponding transverse distance will be the reduced distance required.

EXAMPLE 5. One side of any triangle being given, of any length, to measure the other two sides on the same scale.

Suppose the side AB of the triangle ABC measures 50, what are the measures of the other two sides?



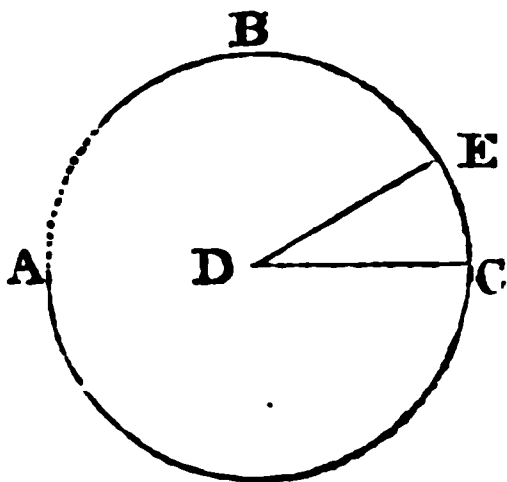
Take AB in your compasses, and apply it transversely to 50 and 50; to this opening of the sector apply the distance AC in your compasses to the same number on both sides of the rule transversely; and where the two points fall will be the measure on the line of lines of the distance required; the distance AC will fall against 63, 63, and BC against 45, 45, on the line of lines.

Use of the line of Chords on the Sector.

The line of chords upon the sector is very useful for protracting any angle, when the paper is so small that an arch cannot be drawn upon it with the radius of a common line of chords.

Suppose it was required to set off an arch of 30° , from the point C of the small circle ABC.

Take the radius DC in your compasses, and set it off transversely from 60° to 60° on the chords, then take the transverse extent from 30° to 30° on the chords; and place one foot of the compasses in C, the other will reach to E, and CE will be the arch required. And by the converse operation any angle or arch may be measured, viz. with any radius describe an arch about the angular point; set that radius transversely from 60° to 60° ; then take the distance of the arch, intercepted between the two legs, and apply it transversely to the chords, which will show the degrees of the given angle.



NOTE. When the angle to be protracted exceeds 60° , you must lay off 60° , and then the remaining part; or if it be above 120° , lay off 60° twice, and then the remaining part. And in a similar manner any arch above 60° may be measured.

Uses of the lines of Sines, Tangents, and Secants.

By the several lines disposed on the sector, we have scales of several radii, so that,

1st. Having a length or radius given, not exceeding the length of the sector when opened, we can find the chord, sine, &c. of an arch to that radius; thus, suppose the chord, sine, or tangent of 20 degrees to a radius of 2 inches be required. Make 2 inches the transverse opening to 60° and 60° on the chords; then will the same extent reach from 45° to 45° on the tangents, and

from 90° to 90° on the sines; so that to whatever radius the line of chords is set, to the same are all the others set also. In this disposition, therefore, if the transverse distance between 20° and 20° on the chords be taken with the compass, it will give the chord of 20 degrees; and if the transverse of 20° and 20° be in like manner taken on the sines, it will be the sine of 20 degrees; and lastly, if the transverse distance of 20° and 20° be taken on the tangents, it will be the tangent of 20 degrees to the same radius of two inches.

2dly. If the chord or tangent of 70° were required. For the chord you must first set off the chord of 60° (or the radius) upon the arch, and then set off the chord of 10° . To find the tangent of 70 degrees, to the same radius, the scale of upper tangents must be used, the under one only reaching to 45° ; making therefore 2 inches the transverse distance to 45° and 45° at the beginning of that scale, the extent between 70° and 70° on the same will be the tangent of 70 degrees to 2 inches radius.

3dly. To find the secant of any arch; make the given radius the transverse distance between 0 and 0 on the secants; then will the transverse distance of 20° and 20° , or 70° and 70° , give the secant of 20° or 70° respectively.

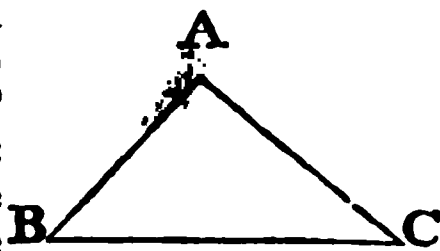
4thly. If the radius and any line representing a sine, tangent, or secant, be given, the degrees corresponding to that line may be found by setting the sector to the given radius, according as a sine, tangent, or secant is concerned; then taking the given line between the compasses, and applying the two feet transversely to the proper scale, and sliding the feet along till they both rest on like divisions on both legs; then the divisions will show the degrees and parts corresponding to the given line.

Use of the line of Polygons.

The use of this line is to inscribe a regular polygon in a circle. For example, let it be required to inscribe an octagon in a circle. Open the sector till the transverse distance 6 and 6 be equal to the radius of the circle; then will the transverse distance of 8 and 8 be the side of the inscribed polygon.

Use of the sector in Trigonometry.

All proportions in trigonometry are easily worked by the double lines on the sector; observing that the sides of triangles are taken off the line of lines, and the angles are taken off the sines, tangents, or secants, according to the nature of the proportion. Thus, if in the triangle ABC we have given $AB=56$, $AC=64$, and the angle $ABC=46^\circ 30'$ to find the rest. In this case we have (*by art. 58, Geometry*) the following proportions, as $AC (64) : \text{sine } \angle B (46^\circ 30') :: AB (56) : \text{sine } \angle C$, and as $\text{sine } B : AC :: \text{sine } A : BC$. Therefore to work these proportions by the sector, take the lateral distance $64=AC$ from the line of lines, and open the sector to make this a transverse distance of $46^\circ 30'=\angle B$ on the sines; then take the lateral distance $56=AB$ on the lines, and apply it transversely on the sines, which will give $39^\circ 24'=\angle C$. Hence the sum of the angles B and C is $85^\circ 54'$, which taken from 180° , leave the angle $A=94^\circ 6'$. Then to work this second proportion, the sector being set at the same opening as before, take the transverse distance of $94^\circ 6'=\text{the angle } A$ on the sines, or, which is the same thing, the transverse distance of its supplement $85^\circ 54'$; then this applied laterally to the lines, gives the sought side $BC=88$. In the same manner we might solve any problem in trigonometry, where the tangents and secants occur, by only measuring the transverse distances on the tangents or secants, instead of measuring them on the sines, as in the preceding example. All the problems that occur in Nautical Astronomy may be solved by the sector, but as the calculation by logarithms is much more accurate, it will be useless to enter into a further detail on this subject.



LOGARITHMS.

IN order to abbreviate the tedious operations of multiplication and division with large numbers, a series of numbers, called logarithms, were invented by Lord Napier, Baron of Marchinston in Scotland, and published in Edinburgh in 1614; by means of which the operation of multiplication may be performed by addition, and division by subtraction; numbers may be involved to any power by simple multiplication, and the root of any power extracted by simple division.

In Table XXVI. are given the logarithms of all numbers from 1 to 9999; to each one ought to be prefixed an index, with a period or dot to separate it from the other part, as in decimal fractions; the numbers from 1 to 100 are published in that table with their indices; but from 100 to 9999 the index is left out for the sake of brevity, but it may be supplied by this general rule, viz. *the index of the logarithm of any integer, or mixed number, is always one less than the number of integer places in the natural number.* Thus the index of the logarithm of any number (integer or mixed) between 10 and 100 is 1, from 100 to 1000 it is 2, from 1000 to 10000 is 3, &c. the method of finding the logarithms from this table will be evident from the following examples.

To find the logarithms of any number less than 100.

RULE. Enter the first page of the table, and opposite the given number will be found the logarithm with its index prefixed.

Thus, opposite 71 is 1.85126, which is its logarithm.

To find the logarithm of any number between 100 and 1000.

RULE. Find the given number in the left hand column of the table of logarithms, and immediately under 0 in the next column, is a number, to which must be prefixed the number 2 as an index (because the number consists of three places of figures) and you will have the sought logarithm.

Thus, if the logarithm of 649 was required; this number being found in the left hand column, against it in the column marked 0 at the top (or bottom) is found 81224, to which prefixing the index 2, we have the logarithm of $649 = 2.81224$.

To find the logarithm of any number between 1000 and 10000.

RULE. Find the three left hand figures of the given number, in the left hand column of the table of logarithms, opposite to which, in the column that is marked at the top (or bottom) with the fourth figure, is to be found the sought logarithm; to which must be prefixed the index 3, because the number contains 4 places of figures.

Thus, if the logarithm of 6495 was required; opposite to 649, and in the column marked 5 at the top (or bottom) is 81258, to which prefix the index 3 and we have the sought logarithm 3.81258.

To find the logarithm of any number above 10000.

RULE. Find the three first figures of the given number, in the left hand column of the table, and the fourth figure at the top or bottom, and take out the corresponding number as in the preceding rule; take also the difference between this logarithm and the next greater, and multiply it by the given number exclusive of the four first figures, cross off at the right hand of the product as many figures as you had figures of the given number to multiply by; then add the remaining left hand figures of this product to the logarithm taken from the table, and to the sum prefix an index equal to one less than the number of integer figures in the given number, and you will have the sought logarithm.

Thus, if the logarithm of 64957 was required: opposite to 649 and under 5 is 81258, the difference between this and the next greater number 81265 is 7. this multiplied by 7 (the last figure of the given number) gives 49, crossing off the right hand figure leaves 4.9 or 5 to be added to 81258, which makes 81263, to this prefixing the index 4, we have the sought logarithm 4.81263.

Again, if the logarithm of 6495738 was required; the logarithm corresponding to 649 at the left. and 5 at the top, is as in the last example 81258,

the difference between this and the next greater is 7, which multiplied by 738 (which is equal to the given number excluding the four first figures) gives 5166, crossing off the three right hand figures of this product (because the number 738 consists of three figures) we have the correction 5 to be added to 81258; and the index to be prefixed is 6 because the given number consists of 7 places of figures, therefore the sought logarithm is 6.81263.

To find the logarithm of any mixed decimal number.

RULE. Find the logarithm of the number as if it was an integer by the last rule, to which prefix the index of the integer part of the given number.

Thus, if the logarithm of the mixed decimal 649.5738 was required;—find the logarithm of 6495738 without noticing the decimal point; this, in the last example, was found to be 81263, to this we must prefix the index 2, corresponding to the integer part 649; the logarithm sought will therefore be 2.81263.

To find the logarithm of any decimal fraction less than unity.

The index of the logarithm of any number less than unity is negative, but to avoid the mixture of positive and negative quantities, it is common to borrow 10 or 100 in the index, which must afterwards be neglected in summing them with other indices; thus instead of writing the index — 1, it is generally written + 9 or + 99; but in general it is sufficient to borrow 10 in the index, and it is what we shall do in the rest of this work. In this way we may find the logarithm of any decimal fraction by the following rules.

RULE. Find the logarithm of a fraction as if it was a whole number;—see how many ciphers precede the first figure of the decimal fraction, subtract that number from 9 and the remainder will be the index of the given fraction.

Thus the log. of 0,0391 is 8.59218; the log. of 0,25 is 9.39794; the log. of 0,0000025 is 4.39794, &c.

To find the logarithm of a vulgar fraction.

RULE. Subtract the logarithm of the denominator from the logarithm of the numerator (borrowing 10 in the index when the denominator is the greatest) the remainder will be the logarithm of the fraction sought.

EXAMPLE I.

Required the log. of $\frac{3}{8}$?

From log. of 3

Take log. of 8

Rem. log. $\frac{3}{8}$ or ,375

0.47712

0.90309

9.57403

EXAMPLE II.

Required the log. of $3\frac{1}{4}$ or $\frac{13}{4}$?

From log. of 13

Take log. of 4

Rem. log. of $3\frac{1}{4}$ or 3,25

1.11394

0.60206

0.51188

To find the number corresponding to any logarithm.

RULE. In the column marked 0 at the top (and bottom) of the table, seek for the next less logarithm, neglecting the index; note the number against it, and carry your eye along that line until you find the nearest less logarithm to the given one, and you will have the fourth figure of the given number at the top, which is to be placed to the right of the three other figures; if you wish for greater accuracy, you must take the difference between this tabular logarithm and the next greater, also the difference between that least tabular logarithm and the given one; to the latter difference annex 2 or more ciphers at the right hand, and divide it by the former difference, and place the quotient* to the right hand of the four figures already found; and you will have the number sought expressed in a mixed decimal, the integer part of which will consist of a number of figures (at the left hand) equal to the index of the logarithm increased by unity.†

Thus, if the number corresponding to the logarithm 1.52634 was required; I look for 52634 in the column marked 0 at the top or bottom, and find it standing opposite to 336; now the index being 1, the sought number must consist of two integer places, therefore it is 33,6.

* This quotient must consist of as many places of figures as there were ciphers annexed, conformable to the rules of the division of decimals. Thus, if the divisor was 40, and the number to which two ciphers were annexed was 2, making 2,00, the quotient must not be estimated as 5, but as 05, and then two figures must be placed to the right of the four figures before found.

† If the index corresponds to a fraction less than unity, you must place as many ciphers to the left of that number as are equal to the index subtracted from 9, the decimal point being placed to the left of these ciphers; in this manner you will obtain the sought number.

If the given logarithm was 2.32838; I find that 32838 stands in the column marked 0 at the top or bottom, directly opposite to 213 which is the number sought, because the index being 2, the number must consist of 3 places of figures.

If the number corresponding to the logarithm 2.57345 was required; I look in the column 0, and find in it, against the number 374, the logarithm 57287, and guiding my eye along that line, I find the given logarithm 57345 in the column marked 5; therefore the mixed number sought is 3745, and since the index is 2, the integer part must consist of 3 places, therefore the number sought is 374.5. If the index had been 1, the number would have been 37.45; and if the index had been 0, the number would have been 3.745. If the index had been 8 corresponding to a number less than unity, the answer would have been 0.03745, &c.

Again, if the number corresponding to the logarithm 5.57811 was required; I look in the column 0, and find in it against 378, and under 5, the logarithm 57807, the difference between this and the next greater logarithm 57813 being 11, and the difference between 57807 and the given number 57811 being 4, to this 4 I affix two ciphers, which make 400, and divide it by 11, the quotient is 36 nearly; this number connected with the former four figures make 378536, which is the number required, since the index being 5 the number must consist of six places of figures.

MULTIPLICATION BY LOGARITHMS.

RULE. Add the logarithms of the two numbers to be multiplied, and the sum will be the logarithm of their product.

EXAMPLE I.

Multiply 25 by 35.	
25 log.	1.39794
35 log.	1.54407
	<hr/>
Product 875 log.	2.94201

EXAMPLE III.

Multiply 3.26 by 0.0025.	
3.26 log.	0.51322
0.0025 log.	7.39794
	<hr/>
Product 0.00815 log.	7.91116

EXAMPLE II.

Multiply 22.4 by 1.8.	
22.4 log.	1.35025
1.8 log.	0.25527
	<hr/>
Product 40.32 log.	1.60552

EXAMPLE IV.

Multiply 0.25 by 0.003.	
0.25 log.	9.39794
0.003 log.	7.47712
	<hr/>
Product 0.00075 log.	6.87506

In the last example the sum of the two indices is 16, but since 10 was borrowed in each number, I have neglected 10 in the sum, and the remainder 6 being less than the other 10, is evidently the index of the logarithm of a fraction less than unity.

DIVISION BY LOGARITHMS.

RULE. From the logarithm of the dividend subtract the logarithm of the divisor, the remainder will be the logarithm of the quotient.

EXAMPLE I.

Divide 875 by 25.	
875 log.	2.94201
25 log.	1.39794
	<hr/>
Quotient 35 log.	1.54407

EXAMPLE III.

Divide 0.00815 by 0.0025.	
0.00815 log.	7.91116
0.0025 log.	7.39794
	<hr/>
Quotient 3.26 log.	0.51322

EXAMPLE II.

Divide 40.32 by 22.4.	
40.32 log.	1.60552
22.4 log.	1.35025
	<hr/>
Quotient 1.8 log.	0.25527

EXAMPLE IV.

Divide 0.00075 by 0.025.	
0.00075 log.	6.87506
0.025 log.	8.39794
	<hr/>
Quotient 0.03 log.	8.47712

In Example III. both the divisor and dividend are fractions less than unity, and the divisor is the least, consequently the quotient is greater than unity. In Example IV. both fractions are less than unity, and since the divisor is the greatest, its logarithm is greater than that of the dividend; for that reason it was necessary to borrow 10 in the index previous to making the subtraction, hence the quotient is less than unity.

INVOLUTION BY LOGARITHMS.

RULE. Multiply the logarithm of the number given, by the index of the power to which the quantity is to be raised, the product will be the logarithm of the power sought. But in raising the powers of any decimal fraction it must be observed, that the first significant figure of the power must be put as many places below the place of units as the index of its logarithm wants of 10 multiplied by the index of the power.

EXAMPLE I.

Required the square of 18?
18 log.

1.25527
2

Answer 324 log.

2.51054

EXAMPLE III.

Required the square of 6,4?
6,4 log.

0.80618
2

Answer 40,96 log.

1.61236

EXAMPLE II.

Required the cube of 13?
13 log.

1.11394
3

Answer 2197 log.

3.34182

EXAMPLE IV.

Required the cube of 0,25?
0,25 log.

9.39794
3

Answer 0,015625.

28.19382

In the last example the index 28 wants 2 of 30 (the product of 10 by the power 3) therefore the first significant figure of the answer, viz. 1, is placed two figures distant from the place of units.

EVOLUTION BY LOGARITHMS.

RULE. Divide the logarithm of the number by the index of the power, the quotient will be the logarithm of the root sought. But if the power whose root is to be extracted is a decimal fraction less than unity, prefix to the index of its logarithm a figure less by one than the index of the power,* and divide the whole by the index of the power, the quotient will be the logarithm of the root sought.

EXAMPLE I.

What is the square root of 324?
324 log.

2)2.51055

Answer 18 log.

1.25527

EXAMPLE II.

Required the cube root of 2197?
2197 log.

3)3.34183

Answer 13

log. 1.11394

EXAMPLE III.

Required the square root of 40,96?
40,96 log.

2)1.61236

Answer 6,4

log. 0.80618

EXAMPLE IV.

Required the cube root of 0,015625?
0,015625 log.

8.19382

Prefix 2 to the index

3)28.19382

Answer 0,25

log. 9.39794

TO WORK THE RULE OF THREE BY LOGARITHMS.

When three numbers are given to find a fourth proportional in arithmetic, we make a statement and say, as the first number is to the second so is the third to the fourth; and by multiplying the second and third together, and dividing the product by the first, we obtain the fourth number sought. To obtain the same result by logarithms, we must *add the logarithms of the second and third numbers together, and from the sum subtract the logarithm of the first number, the remainder will be the logarithm of the sought fourth number.*

EXAMPLE I.

If 6 yards of cloth cost 5 dollars, what will 20 yards cost?

As 6

log. 0.77815

Is to 5

log. 0.69897

So is 20

log. 1.30103

Sum of 2d. and 3d.

2.00000

Subtract first

0.77815

To 16.67

log. 1.22185

The answer therefore is 16 dollars and 67-100ths or 16 dollars and 67 cents.

EXAMPLE II.

If a ship sails 20 miles in 7 hours, how much will she sail in 21 hours at the same rate?

As 7

log. 0.84510

Is to 20

log. 1.30103

So is 21

log. 1.32222

Sum of 2d. and 3d.

2.62325

Subtract the first

0.84510

To 60

log. 1.77815

The answer is

60 miles.

* In this rule it is supposed that 10 was borrowed in finding the index of the decimal according to the rule page 30.

LOGARITHMS.

33

To calculate COMPOUND INTEREST by Logarithms.

To 100 dollars add its interest for one year; find the logarithm of this sum and reject 2 in the index, then multiply it by the number of years and parts of a year, for which the interest is to be calculated: to the product add the logarithm of the sum put at interest; the sum of these two logarithms will be the logarithm of the amount of the given sum for the given time.

EXAMPLE.

Required the amount of the principal and interest of 355 dollars, let at 6 per cent. compound interest for 7 years?

Adding 6 to 100 gives 106, whose logarithm, rejecting 2 in the index, is	0.02531
Multiplied by	7
Product.	0.17717
Principal 355 dollars log.	2.55023
Sum gives the log. of 533,93	2.72740

Therefore the amount of principal and interest is 533 dollars and 83 cents.

To find the Logarithm-sine, Tangent, or Secant, corresponding to any number of Degrees and Minutes, by Table XXVII.

The given number of degrees must be found at the bottom of the page when between 45° and 135° , otherwise at the top, the minutes being found in the column marked M, which stands on the side of the page on which the degrees are marked; thus, if the degrees are less than 45, the minutes are to be found in the left hand column, &c. and it must be noted that if the degrees are found at the top, the names of hour, sine, co-sine, tangent, &c. must also be found at the top; and if the degrees are found at the bottom, the names sine, co-sine, &c. must also be found at the bottom. Then opposite to the number of the minutes will be found the log-sine, log-secant, &c. in the column marked sine, secant, &c. respectively.

EXAMPLE I.

Required the log. sine of $28^{\circ} 37'$?

Find 28° at the top of the page, directly below which, in the left hand column, find 37'; against which in the column marked sine is 9.69029, the log. sine of the given number of degrees; and in the same manner the tangents, &c. are found.

EXAMPLE II.

Required the log. secant of $126^{\circ} 20'$?

Find 126° at the bottom of the page, directly above which, in the left hand column, find 20'; against which, in the column marked secant, is 10.22732 required.

To find the Logarithm-sine, Co-sine, &c. for Degrees, Minutes, and Seconds, by Table XXVII.

Find the numbers corresponding to the even minutes next above and below the given degrees and minutes, and take their difference; then say, as 60" is to the number of seconds in the proposed number, so is that difference to a correction to be applied to the number corresponding to the least number of degrees and minutes; additive if it is the least of the two numbers taken from the table, otherwise subtractive.

EXAMPLE I.

Required the log. sine of $24^{\circ} 16' 48''$?

Sine of $24^{\circ} 16'$	9.61382
Sine of $24^{\circ} 17'$	9.61411

Diff. 29

Then, as $60'' : 48'' :: 29 : 23$, which, added to the number corresponding to $24^{\circ} 16'$, gives 9.61405 the log. sine of $24^{\circ} 16' 48''$.

EXAMPLE II.

Required the log. secant of $105^{\circ} 20' 16''$?

Secant of 105.20 log.	10.57768
105.21	10.57722

Diff. 46

Then as $60'' : 16'' :: 46 : 12$, which, subtracted from the number corresponding to $105^{\circ} 20'$, gives 10.57756, the log. sec. of $105^{\circ} 20' 16''$.

If the given seconds be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, or $\frac{1}{6}$, or any other even parts of a minute, the like parts may be taken of the difference of the logarithms, and added or subtracted as above, which may be frequently done by inspection.

To find the Degrees, Minutes, and Seconds, corresponding to any given Logarithm-sine, Co-sine, &c. by Table XXVII.

Find the two nearest numbers to the given logarithm-sine, co-sine, &c. in the column marked sine, co-sine, &c. respectively, one being greater and the other less, and take their difference; take also the difference between the given logarithm and the logarithm corresponding to the least number of degrees and minutes: then say, as the first found difference is to the second found difference, so is 60" to a number of seconds to be annexed to the smallest number of degrees and minutes before found.

EXAMPLE I.

Find the degrees, minutes, and seconds (less than 90°) corresponding to the log. sine 9.61405.

Next less log. $24^\circ 16'$	9.61382	Log. of least numb. $24^\circ 16'$ is	9.61382
Greater $24 17$	9.61411	Given log.	9.61405

29

23

Then say, as $29 : 23 :: 60'' : 48''$ which annexed to $24^\circ 16'$ give $24^\circ 16' 48''$ answering to log. sine 9.61405. Subtracting $24^\circ 16' 48''$ from 180° , there remains $155^\circ 43' 12''$, the log. sine of which is also 9.61405.

EXAMPLE II.

Find the degrees, minutes, and seconds (above 90°) corresponding to the log. secant 10.56703.

Secant $105^\circ 43'$ log.	10.56722	Log. of the least numb. $105^\circ 43'$	10.56722
Secant $105 44$	10.56677	Given log.	10.56703

45

19

Then as 45 is to 19, so is $60''$ to $25''$, which annexed to $105^\circ 43'$, gives $105^\circ 43' 25''$, the degrees, minutes, and seconds required.

To find the Arithmetical Complement of any Logarithm.

The arithmetical complement of any logarithm, is what it wants of 10,00000 and is used to avoid subtraction. For when working any proportion by logarithms, you may add the arithmetical complement of the logarithm of the first term, instead of subtracting the logarithm itself, observing to neglect 10 in the index of the sum of the logarithms. The arithmetical complement of any logarithm is thus found:—Begin at the index, and write down what each figure wants of 9, except the last significant figure, which take from 10*.

EXAMPLE.

Required the arithmetical complement of 9.62595?

For the first figure 9, write 0; for 6, 3; for 2, 7; for 5, 4; for 9, 0; and for the last figure 5, write 5; thus the arithmetical complement is 0.37405.

In the same manner the arithmetical complement of 1.86563 is 8.13437, the ar. co. of 10.33133 is 9.66867, and the ar. co. of 1.22800 is 8.77200. To illustrate the method of using the arithmetical complement of any logarithm, I shall here calculate the examples as given in page 32.

EXAMPLE I.

As 6	log. ar. co.	9.22185
Is to 5	log.	0.69897
So is 20	log.	1.30103
To 16,67	log.	1.22185

EXAMPLE II.

As 7	log. ar. co.	9.15490
Is to 20	log.	1.30103
So is 21	log.	1.32222
To 60	log.	1.77815

* When the index of the given logarithm is greater than 10, as in some of the numbers of Table XXVII. the left hand figure of it must be neglected; and when there are any ciphers to the right hand of the last significant figure, you may place the same number of ciphers to the right hand of the other figures of the arithmetical complement.

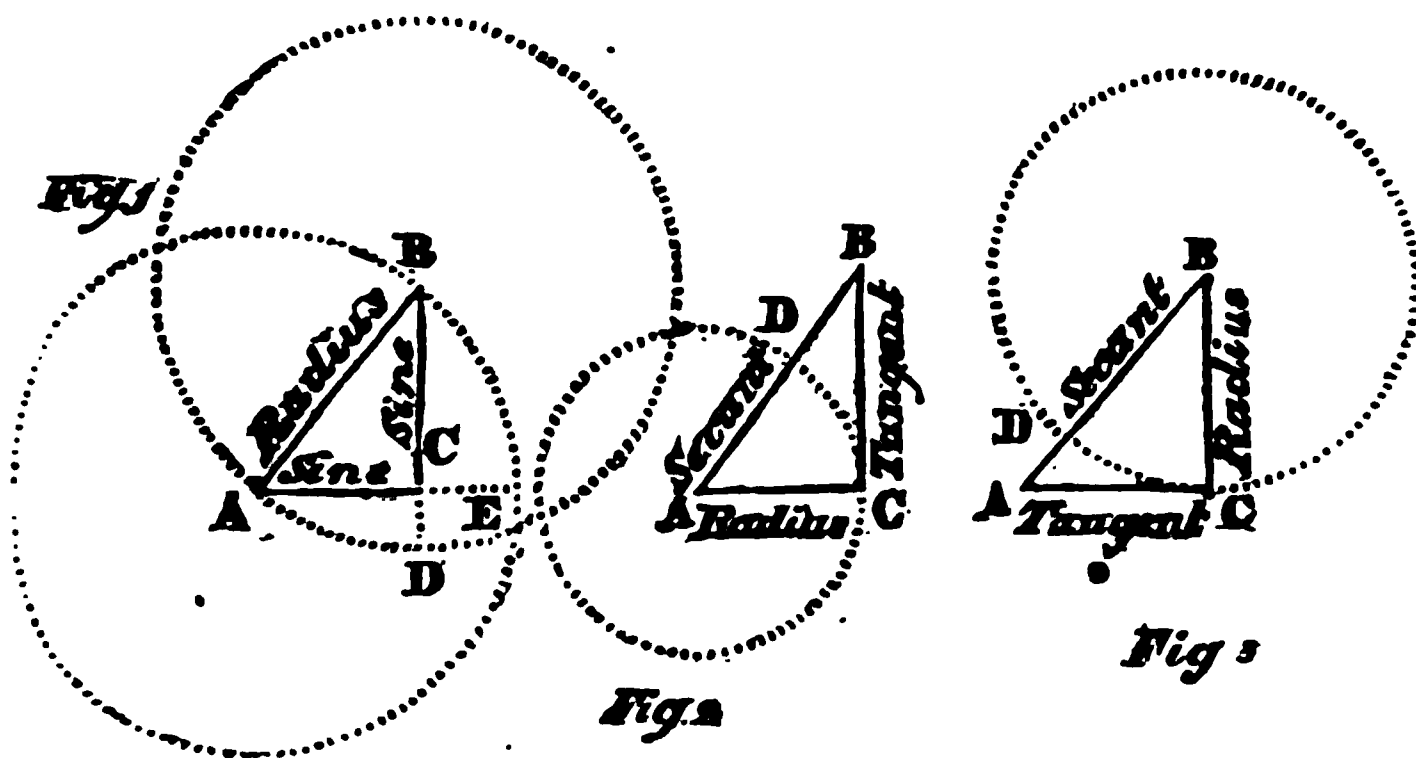
PLANE TRIGONOMETRY.

PLANE TRIGONOMETRY is the science which shows how to find the measures of the sides and angles of plane triangles, some of them being already known. It is divided into two parts, right-angled and oblique-angled: in the former case, one of the angles is a right angle or 90° ; in the latter they are all oblique.

In every plane triangle there are six parts, viz. three sides and three angles; any three of which being given (except the three angles) the other three may be found by various methods, viz. by Gunter's Scale, by the sliding rule, by the sector, by geometrical construction, or by arithmetical calculation. We shall explain each of these methods;* but the latter is by far the most accurate; it is performed by the help of a few theorems, and a trigonometrical canon, exhibiting the natural or the logarithmic sines, tangents, and secants, to every degree and minute of the quadrant.† The theorems alluded to are the following:

THEOREM I.

In any right angled triangle, if the hypotenuse be made radius, one side will be the sine of the opposite angle, and the other its co-sine; but if either of the legs be made radius, the other leg will be the tangent of the opposite angle, and the hypotenuse will be the secant of the same angle.



1st. If in the right-angled plane triangle ACB (fig. 1) we make the hypotenuse AB radius, and upon the centre A describe the arch BE, to meet AC produced in E; then it is evident that BC is the sine of the arch BE (or the sine of the angle BAC) and that AC is the co-sine of the same angle: and if the arch AD be described about the centre B, AC will be the sine of the angle ABC, and BC its co-sine.

2dly. If the leg AC (fig. 2) be made radius, and the arch CD be described about the centre A; CB will be the tangent of that arch, or the tangent of the angle CAB; and AB will be its secant.

3dly. If the leg BC (fig. 3.) be made radius, and the arch CD be described about the centre B; CA will be the tangent of that arch, or the tangent of the angle B; and AB will be its secant.

Now it has been already demonstrated (*in art. 55. Geom.*) that the sine, tang. sec. &c. of any arch in one circle, is to the sine, tang. sec. &c. of a similar arch in another circle as the radius of the former circle to the radius of the latter. And since in any right-angled triangle there are given either two sides, or the angles and one side, to find the rest; we may, if we wish to find

* It will not be necessary to add any further description of the uses of the sector or sliding rule, for what we have already given will be sufficient for any one, tolerably well versed in the use of Gunter's Scale.
† See Tables XXIV. and XXVII.

a side, make any side radius; then say, as the tabular number of the same name as the given side is to the given side of the triangle, so is the tabular number of the same name as the required side, to the required side of the triangle. If we wish to find an angle, one of the given sides must be made radius; then say, as the side of the triangle made radius, is to the tabular radius, so is the other given side to the tabular sine, tangent, secant, &c. by it represented; which being sought for in the table of sines, &c. will correspond to the degrees and minutes of the required angle.

THEOREM II.

In all plane triangles, the sides are in direct proportion to the sines of their opposite angles (by art. 58, Geom.)

Hence, to find a side, we must say, as the sine of an angle is to its opposite side, so is the sine of either of the other angles to the side opposite thereto. But if we wish to find an angle, we must say, as any given side is to the sine of its opposite angle, so is either of the other sides to the sine of its opposite angle.

THEOREM III.

In every plane triangle, it will be, as the sum of any two sides is to their difference, so is the tangent of half the sum of the two opposite angles to the tangent of half their difference (by art. 59, Geom.)

THEOREM IV.

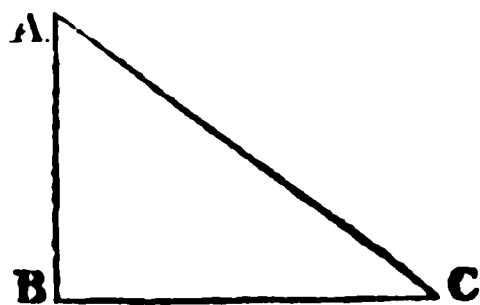
As the base of any plane triangle is to the sum of the two sides, so is the difference of the two sides to twice the distance of a perpendicular (let fall upon the base from the opposite angle) from the middle of the base (by art. 60, Geom.)

THEOREM V.

In any plane triangle, as the rectangle contained by any two sides including a sought angle, is to the rectangle contained by the half sum of the sides and the half sum decreased by the other side, so is the square of radius to the square of the co-sine of half the sought angle (by art. 61, Geom.)

[In addition to these theorems, it will not be amiss for the learner to recall to mind the following articles, most of which have been already demonstrated.]

1. In every triangle, the greatest side is opposite to the greatest angle; and the greatest angle opposite to the greatest side.
2. In every triangle equal sides subtend equal angles. (Art. 39, Geom.)
3. The three angles of any plane triangle are equal to 180° . (Art. 35, Geom.)
4. If one angle of a triangle be obtuse, the rest are acute; and if one angle be right, the other two together make a right angle, or 90° ; therefore, if one of the acute angles of a right-angled triangle be known, the other is found by subtracting the known angle from 90° . If one angle of any triangle be known, the sum of the other two is found by subtracting the given angle from 180° ; and if two of the angles be known, the third is found by subtracting their sum from 180° .
5. The complement of an angle is what it wants of 90° , and the supplement of an angle is what it wants of 180° .



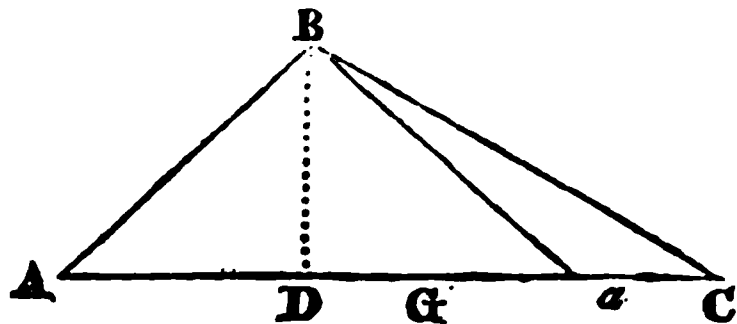
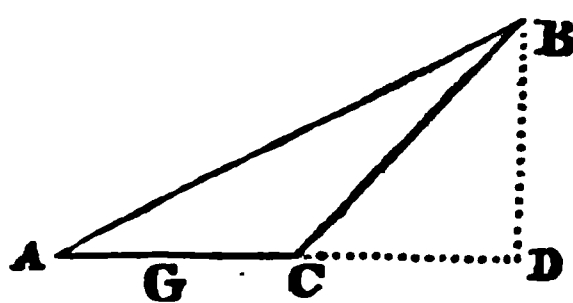
In the two following tables we have collected all the rules necessary for solving the various cases of Right-Angled and Oblique-Angled Trigonometry.

RIGHT-ANGLED TRIGONOMETRY.

Case.	Given.	Sought.	Solutions.
1	Hyp. AC. Angles.	Leg BC. Leg AB.	Rad. : hyp. AC. : : sine A. : leg BC. Rad. : hyp. AC. : : sine C. : leg AB.
2 & 3	Leg BC. Angles.	Leg AB. Hyp. AC.	Rad. : leg BC. : : tang. C. : leg AB. Rad. : leg BC. : : sec. C. : hyp. AC. Or Sine A. : leg BC. : : rad. : hyp. AC.
4 & 5	Hyp. AC. Leg AB.	Angles. Leg BC.	Hyp. AC. : rad. : : leg AB. : sine C. whose comp. is A. Rad. : hyp. AC. : : sine A. : leg BC.
6	Both legs. AB & BC.	Angles. Hyp. AC.	Leg BC. : rad. : : leg AB. : tang. C. whose comp. is A. Sine C. : leg AB. : : rad. : hyp. AC. Or rad. : leg BC. : : sec. C. : hyp. AC.

OBLIQUE-ANGLED TRIGONOMETRY.

37



Case	Given.	Sought.	Solutions.
1	The angles and side A B.	Side BC. Side AC.	Sine C : side AB :: sine A : side BC. Sine C : side AB :: sine B : side AC.
2 & 3	Two sides A B, BC, and angle C opposite to one of them.	Angle A. Angle B. Side AC.	Side AB : sine C :: side BC : sine A, which added to C, and the sum subtracted from 180° gives B. Sine C : side AB :: sine B : side AC.
4 & 5	Two sides A C, A B and the included angle A	Angles C and B. Side BC.	Subtract half the given angle A from 90°, the remainder is half the sum of the other angles. Then say, as the sum of the sides AC, AB is to their difference, so is the tangent of the half sum of the other angles to the tangent of half their difference; which added to and subtracted from the half sum, will give the two angles B and C the greatest angle being opposite to the greatest side. Sine B : side AC :: sine A : side BC.
6	All three sides.	All the angles. Either angle, as A.	Let fall a perpendicular BD opposite to the required angle; then as AC : sum of AB, BC :: their difference : twice DG, the distance of the perpendicular from the middle of the base; hence, AD, CD are known, and the triangle ABC is divided into two right-angled triangles BCD, BAD. then by cases 4 and 5 of right-angled trigonometry, we may find the angle A or C. Either of the angles, as A, may also be found by the following rule. From half the sum of the three sides subtract the side BC opposite to the sought angle; take the logarithms of the half sum and remainder, to which add the arithmetical complements of the logarithms of the sides AB, AC (including the sought angle;) half the sum of these four logarithms will be the logarithmic co-sine of half the sought angle.

In working by logarithms with any of the preceding rules, you must remember, that the logarithm of the first term of the analogy is to be subtracted from the sum of the logarithms of the second and third terms, the remainder will be the logarithm of the sought fourth term.

When the first term is radius (whose logarithm is 10,00000) you need only reject an unit in the second left hand figure of the index of the sum of the second and third terms. But when the radius occurs in the second or third term, you must suppose an unit to be added to the second left hand figure of the index of the other term, and subtract therefrom the logarithm of the first term.



RIGHT-ANGLED TRIGONOMETRY.

Solution of the six cases in right-angled Trigonometry.

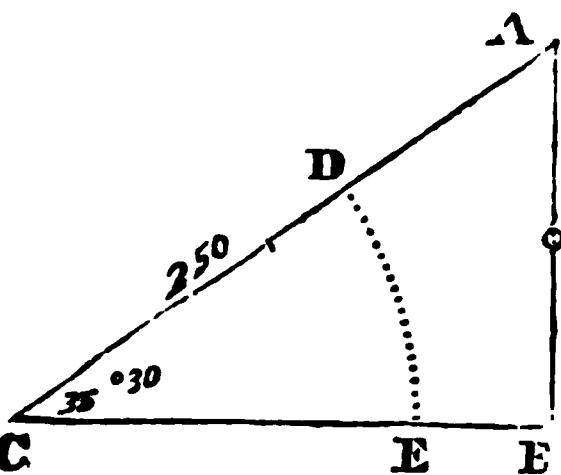
CASE I.

The angles and hypotenuse given, to find the legs.

Given the hypotenuse AC 250 leagues, and the angle C opposite to the side AB = $35^{\circ} 30'$ to find the base CB and perpendicular AB.

BY PROJECTION.

Draw the base CB of any length; with an extent equal to the chord of 60° and on C as a centre, describe the arch DE; from E to D lay off $35^{\circ} 30'$ taken from the line of chords,* through C and D draw the line AC, which make equal to 250; from A let fall the perpendicular AB, to cut CB in B, and it is done; for CB will be 203.5, and AB = 145.2.



* In all projections of this kind the angles are measured from the line of chords, the radius used for describing arches by which the angles are to be measured, being equal to the chord of 60° , the sides of the triangles are measured by scales of equal parts as was before observed.

BY LOGARITHMS.

By making the hypotenuse CA radius, it will be,
To find the base BC.

As radius	10.00000
Is to the hypot. AC 250	2.39794
So is the sine ang. A $54^{\circ} 30'$	9.91069
<hr/>	
To the base BC 203.5	2.30863

To find the perpendicular AB.

As radius	10.00000
Is to the hypot. AC 250	2.39794
So is sine ang. C $35^{\circ} 30'$	9.76395
<hr/>	
To the per. AB 145.2	2.16189

BY GUNTER'S SCALE.

In all proportions wrought by Gunter's Scale, when the first and second terms are of the same kind, the extent from the first term to the second, will reach from the third to the fourth.

Or when the first and third terms are of the same kind.

The extent from the first term to the third will reach from the second to the fourth; that is, set one point of the compasses on the division expressing the first term, and extend the other point to the division expressing the third term; then, without altering the opening of the compasses, set one point on the division representing the second term, and the other point will fall on the division showing the fourth term or answer.

In the present example the work will be as follows:

Extend from radius or 90° , to $54^{\circ} 30'$ on the line of sines; that extent will reach from 250, the hypotenuse, to 203.5, the base on the line of numbers; and the extent from radius, or 90° , to $35^{\circ} 30'$ on the line of sines, will reach from 250 to 145.2 on the line of numbers.

Observe the like in all that follows, except in those proportions where the word secant is mentioned, which cases must be wrought by considering the hypotenuse radius,* there being no line of secants on the common Gunter's Scale, although it might easily be marked on the line of sines.

Note. The radius, according to the nature of the proportion, may be either of the following quantities.

8 points on the line of rhumbs.

90° on the line of sines.

4 points on the line of tan-rhumbs.

45° on the line of tangents.

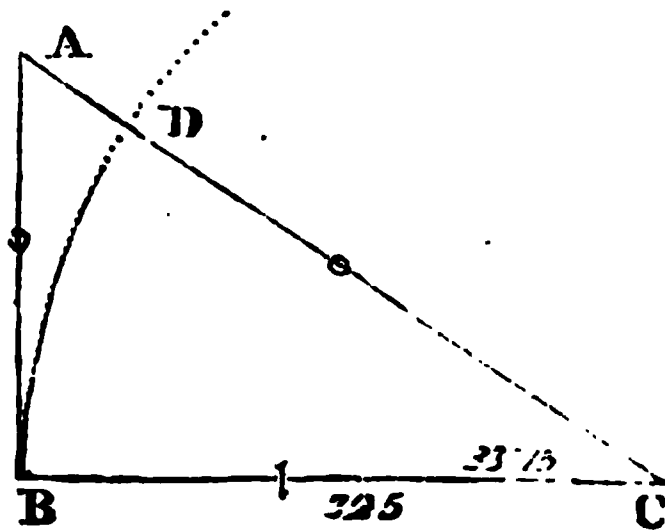
CASES II. AND III.

The angles and one leg given, to find the hypotenuse and other leg.

The angle ACB $33^{\circ} 15'$, the leg BC 325 miles, given, to find the hypotenuse and the other leg.

BY PROJECTION.

Draw the line BC, which make equal to 325 miles; on B erect the perpendicular BA; on C, as a centre, with the chord of 60° sweep the arch BD, which make equal to $33^{\circ} 15'$; draw CD, and continue it to cut AB in A, and it is done; for AB being measured on the same scale that BC was, will be 213.1, and AC 388.6 miles.



BY LOGARITHMS.

By making the base BC radius, it will be,

To find the perpendicular AB.

As radius 45°	10.00000
Is to the base BC 325	2.51188
So is tang. ang. C $33^{\circ} 15'$	9.81666
<hr/>	
To the perpen. AB 213.1	2.32854

To find the hypotenuse AC.

As radius 90°	10.00000
Is to the base BC 325	2.51188
So is sec. ang. C $33^{\circ} 15'$	10.07765
<hr/>	
To the hypot. AC 388.6	2.58953

BY GUNTER.

Extend from 45° to $33^{\circ} 15'$ on the line of tangents; that extent will reach from the base 325 to the perpendicular 213.1 on the line of numbers.

2dly. Extend from $56^{\circ} 45'$ to radius on the line of sines; that extent will reach from the base 325 to the hypotenuse 388.6 on the line of numbers.

* Or by using in the analogy radius : cos. angle instead of secant angle : Radius and radius : sine angle instead of co-secant angle : Radius.

RIGHT-ANGLED TRIGONOMETRY.

39

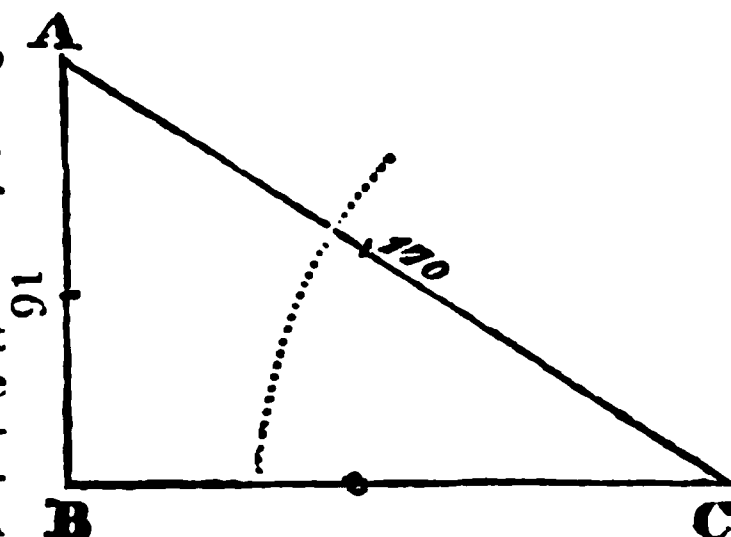
CASES IV. AND V.

The hypotenuse and one leg given, to find the angles and other leg.

The leg AB 91, the hypotenuse AC 170, given, to find the angle ACB, or BAC, and the leg BC.

BY PROJECTION.

Draw BC at pleasure; on B erect the perpendicular BA, which make equal to 91; take 170 in your compasses, and with one foot on A, describe an arch to cut BC in C; join A and C, and it is done; for the angle C will be $32^{\circ} 22'$, the angle A $57^{\circ} 38'$, and BC 143.6.



BY LOGARITHMS.

By making the hypotenuse radius it will be,

To find the angle C.		To find the base BC.*	
As the hypotenuse 170	2.23045	As radius	10.00000
Is to radius	10.00000	Is to the hypotenuse 170	2.23045
So is the perpendicular 91	1.95904	So is sine ang. A $57^{\circ} 38'$	9.92667
<hr/>		<hr/>	
To sine angle C $32^{\circ} 22'$	9.72859	To the base BC 143.6	2.15712

BY GUNTER.

Extend from the hypotenuse 170 to the perpendicular 91 on the line of numbers; that extent will reach from radius to the angle C, or the complement of angle A $= 32^{\circ} 22'$ on the line of sines.

2dly. Extend from radius to the angle A $57^{\circ} 38'$ on the line of sines: that extent will reach from the hypotenuse 170 to the base 143.6, on the line of numbers.

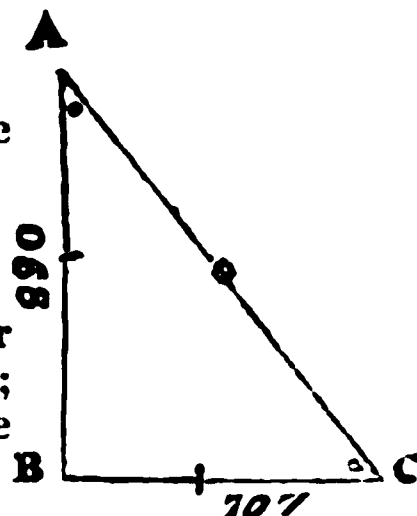
CASE VI.

The legs given, to find the angles and hypotenuse.

The legs AB 890, BC 707, given, to find the angle BAC or ACB, and the hypotenuse AC.

BY PROJECTION.

Make BC=707, and on B erect the perpendicular BA, which make equal to 890; join AC, and it is done; for the angle C will be $51^{\circ} 32'$; consequently the angle A $38^{\circ} 28'$, and the hypotenuse 1137.



BY LOGARITHMS.

By making the base radius, it will be,

To find the angle C.		To find the hypotenuse AC.†	
As the base 707	2.84942	As radius	10.00000
Is to radius	10.00000	Is to the base 707	2.84942
So is the perpendicular 890	2.94939	So is the sec. ang. C $51^{\circ} 32'$	10.20617
<hr/>		<hr/>	
To tan. ang. C $= 51^{\circ} 32'$	10.09997	To the hyp. AC=1137	3.05559

BY GUNTER.

The extent from 707 to 890 on the line of numbers will reach from radius, or 45 degrees, to the angle C $51^{\circ} 32'$ on the line of tangents.

2dly. The extent from the angle C $51^{\circ} 32'$ to radius, or 90° , on the line of sines, will reach from the base 890 to the hypotenuse 1137, on the line of numbers.

* When you take the log. sines, or tangents to the nearest minute only, it is best to use this canon for finding BC, which is more correct than the one found by making the perpendicular radius; because the variation of the log. sine of an arch is less than the corresponding variation of the log. tangent.

† When you are finding AC it is best to make the greatest side radius, for the reason mentioned in the last note.

QUESTIONS

To exercise the learner in Right-Angled Plane Trigonometry.

Quest. 1. The hypotenuse 496 miles, and the angle opposite to the base $56^{\circ} 15'$, given, to find the base and perpendicular.

Ans. Base 412.4, and the perpendicular 275.6 miles.

Quest. 2. The perpendicular 275 leagues, and the angle opposite to the base $56^{\circ} 15'$, given, to find the hypotenuse and base.

Ans. The hypotenuse 495, and base 411.6 leagues.

Quest. 3. The base 33 yards, and the angle opposite to the perpendicular $53^{\circ} 26'$, given, to find the hypotenuse and perpendicular.

Ans. Hypotenuse 55.39, and the perpendicular 44.49 yards.

Quest. 4. The hypotenuse 575, and perpendicular 50 miles, given, to find the base.

Ans. Base 572.8 miles.

Quest. 5. The hypotenuse 59, and the base 33 miles, given, to find the perpendicular.

Ans. Perpendicular 48.9 miles.

Quest. 6. The base 33, and perpendicular 52 leagues given, to find the hypotenuse.

Ans. Hypotenuse 61.59 leagues.

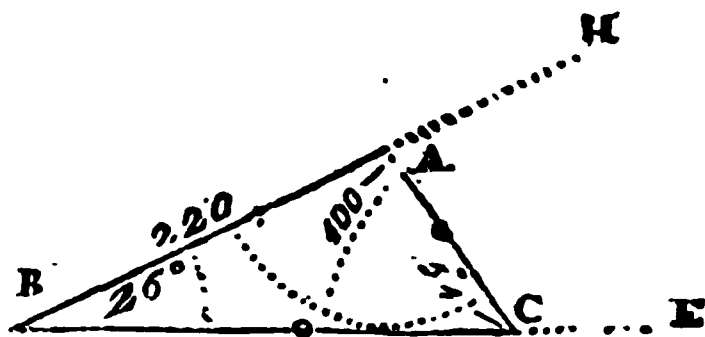


OBLIQUE TRIGONOMETRY.

CASE I.

Two angles and one side given, to find either of the legs.

Given the angle $BAC = 100^{\circ}$
the angle $ACB = 54^{\circ}$ and the
leg $AB = 220$ to find the sides.



BY PROJECTION.

Subtract the sum of the angles A and C from 180° , the remainder will be the angle $B = 26^{\circ}$. Draw the indefinite line BE, also the line BH, making the angle $EBH = 26^{\circ}$, on BH set off BA 220. On A make the angle $BAC = 100^{\circ}$; then AC will intersect the line BE in the point C, which completes the triangle, and BC will measure (on the same scale from which BA was laid down) 268 nearly, and AC 119.

BY LOGARITHMS by Theorem II.

To find BC.		To find DC.	
As the sine of the angle C 54°	9.90796	As sine ang. C 54°	9.90796
Is to the side AB 220	2.34242	Is to the side AB 220	2.34242
So is the sine of the ang. A 100°	9.99335	So is the sine ang. B 26°	9.64184
	12.33577		11.98426
	9.90796		9.90796
To the side BC 267.8	2.42781	To side AC 119.2	2.07630

BY GUNTER.

The extent from the angle $C = 54^{\circ}$ to the angle A or its supplement 80° on the sines, will reach from $AB = 220$ to $BC = 268$ on the line of numbers.

2dly. The extent from the angle $C = 54^{\circ}$ to the angle $B = 26^{\circ}$, on the sines, will reach from $AB = 220$ to $AC = 119$ on the line of numbers.

OBLIQUE TRIGONOMETRY.

41

CASES II. AND III.

Two sides and an angle opposite to one of them being given, to find the other angles and the third side.

NOTE. It may be proper to observe, that if the given angle be obtuse, the angle sought will be acute: but when the given angle is acute and opposite to a lesser given side,

then it is doubtful whether the required angle is acute or obtuse; it ought therefore to be given by the conditions of the problem.

EXAMPLE. Let there be given the side BC 410, the side AB 640, and the angle A $23\frac{1}{2}^\circ$, to find the other side AC, and the angles ABC, BCA.

BY PROJECTION.

Draw the indefinite line FE, make the angle DAE = $23\frac{1}{2}^\circ$, on AD set off AB = 640, then on B, with 410 in your compasses taken from the same scale, describe an arch cutting FE in the points C and G, join BC, BG, and it is done; for the triangle may be either ACB, or AGB, according as the angle C, or G, is acute or obtuse; if that angle be acute, the triangle will be ABC; the side AC will measure 908, the angle ACB will measure $38\frac{1}{2}^\circ$, and the angle ABC will measure 118° nearly; but if the angle at the base be obtuse, the triangle will be AGB; the side AG will measure 266, the angle AGB will measure $141\frac{1}{2}^\circ$ and the angle ABG 15° .

If the side BC had been given greater than AB, there could have been only one answer to this problem; for in that case, the point G would have fallen on the continuation of the line CA towards F, in which case the angle A of the triangle would become equal to FAB, instead of being equal to its supplement, as is required by the conditions of the problem.

BY LOGARITHMS, by Theorem II.

To find the angle C or G.		To find AC.	
As the side BC 410	2.61278	As sine angle C $38^\circ 30'$	9.79410
Is to the sine of angle A $23\frac{1}{2}^\circ$	9.60070	Is to AB 640	2.80618
So is the side AB 640	2.80618	So is sine angle ABC 118°	9.94593
	12.40688		12.75211
	2.61278		9.79410
			2.95801
To sine ang. C $38^\circ 30'$ or G $141^\circ 30'$		To the side AC 907,8	
Angle A add $23^\circ 30'$	$23^\circ 30'$		
Subtract $62^\circ 0'$ or $165^\circ 0'$		To find AG.	
From $190^\circ 0'$ or $180^\circ 0'$		As sine angle G $141^\circ 30'$	9.79410
		Is to AB 640	2.80618
		So is sine angle ABG 15°	9.41309
			12.21918
			9.79410
			2.42508
		To the side AG 266,1	

BY GUNTER.

1st. The extent from BC = 410 to AB = 640, on the line of numbers, will reach from A = $23\frac{1}{2}^\circ$, to $38\frac{1}{2}^\circ$, on the line of sines, which is equal to the angle C; its supplement $141^\circ 30'$ being equal to the angle G.

2dly. The extent from the angle C = $38^\circ 30'$ to $62^\circ 0'$ (the supplement of the angle ABC, $118^\circ 0'$) on the sines, will reach from AB = 640 to 908, on the line of numbers; therefore the side AC = 908.

Or, the extent from $38^\circ 30'$ (the supplement of the angle G) to the angle ABG = $15^\circ 0'$ on the sines, will reach from AB = 640 to 266, on the line of numbers: hence AG = 266.

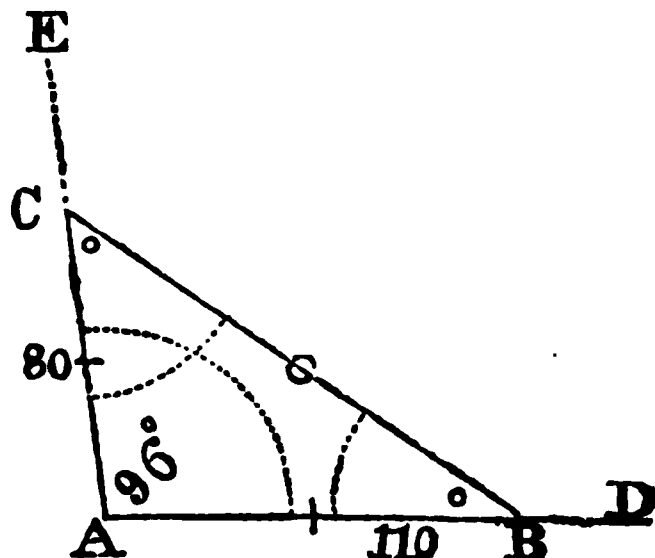
CASES IV. AND V.

Two sides and their contained angle being given, to find either of the other angles and the third side.

Given the side AB 110 m. AC 80 m. and angle BAC $96^{\circ} 0'$ to find the angles BCA and CBA.

BY PROJECTION.

Draw the indefinite right line AD, on which set off AB=110; make the angle EAB= 96° ; and on AE set off AC=80; join BC, and it is done; for BC will measure on the former scale 143, and the angles B and C will measure $33^{\circ} 55'$ and $50^{\circ} 5'$ respectively on the line of chords.



BY LOGARITHMS.

To find the angles B and C by Th. III.
As sum of sides AC and AB 190 2.27875
Is to their difference 30 1.47712
So is tang. $\frac{1}{2}$ sum op. \angle 's } 42° 9.95444
or comp. $\frac{1}{2}$ ang. A. }

11.43156
2.27875

To tang. half diff. $8^{\circ} 5' = 9.15281$

Sum is angle C 50 5
Diff. is angle B 33 55

To find the side BC by Theorem II.
As sine ang. B $33^{\circ} 55'$ 9.74662
Is to AC 80 1.90309
So is sine ang. A $96^{\circ} 0'$ } 9.99761
or its sup. $84^{\circ} 0'$ }

11.90070
9.74662

To side BC 142.6

2.15408

BY GUNTER.

1st. The extent from the sum of the sides 190 to their difference 30 on the line of numbers, will reach from the half sum of the angles B and C 42° to their half difference $8^{\circ} 5'$ on the line of tangents. The sum of which half sum and half difference gives the angle C $50^{\circ} 5'$ and their difference the angle B $33^{\circ} 55'$; the greatest angle being opposite to the greatest side.

2dly. The extent from the angle B $33^{\circ} 55'$, to the angle A 96° (or its supplement 84°) on the line of sines, will reach from the side AC 80 to the side BC 142.6 on the line of numbers.

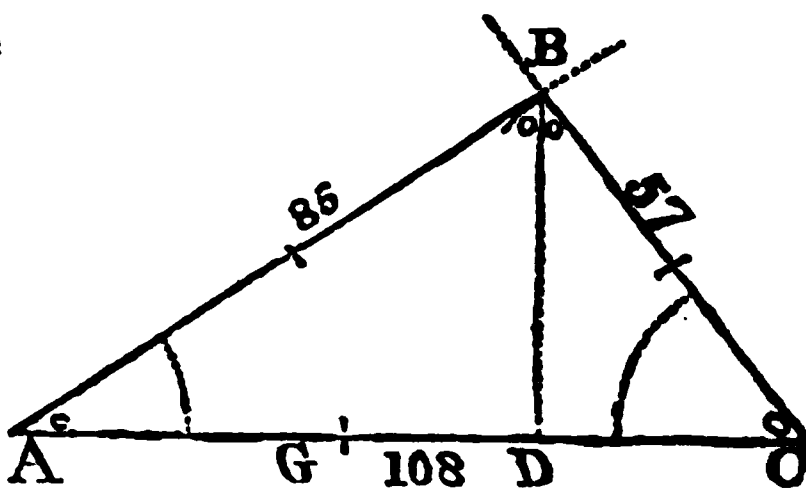
CASE VI.

The three sides of a plane triangle given, to find the angles.

The sides AB 85, BC 57, AC 108 given, to find the angles ABC, BAC, BCA.

BY PROJECTION.

Draw the line AC, and make it equal to 108; take 85 in your compasses, and with one foot on the point A, describe an arch; then take the distance 57 in your compasses, and with one foot on C, describe another arch intersecting the former arch in the point B; join AB, CB, and it is done. For the angle A being measured will be found $= 31\frac{1}{2}^{\circ}$, B $= 97^{\circ}$, and the angle C $= 51\frac{1}{2}^{\circ}$ nearly.



OBLIQUE TRIGONOMETRY.

43

BY LOGARITHMS, by Theorem IV.

Suppose BD to be drawn perpendicular to AC, and that AG=GC.

Side AB=85	As the base AC 108	2.03342
Side BC=57	Is to the sum of the sides AB and BG 142	2.15229
	So is diff. of the sides AB and BC 28	1.44716
Sum of the sides 142		
Diff. of the sides 28		3.59945
		2.03342
Half base AC 54		
DG 18.4	To twice DG 36,8	1.56603
	Its half=DG 18,4	
Sum is greater seg. AD 72.4		
Diff. is least seg. DC 35.6		

Having divided the triangle into two right-angled triangles, the hypotenuses and bases of which are given, we may find the angles by Theorem I.

To find the angle BAD.		To find the angle BCD.	
As the hypotenuse AB 85	1.92942	As the hypotenuse BC 57	1.75587
Is to radius 90°	10.00000	Is to radius 90°	10.00000
So is the greater seg. AD 72,4	1.85974	So is the lesser seg. DC 35,6	1.55145
		To co-sine of BCD=51° 21'	9.79558
		BAD=31 36	
To co-sine BAD=31° 36'	9.93032	Sum 82 57	
		Subtract from 180	
		Remains angle ABC 97 3	

BY GUNTER.

1st. The extent from the base AC=108, to the sum of the sides 142, on the line of numbers, will reach from the difference of the sides 28, to twice DG 36.8 on the same line of numbers.

2dly. The extent from the hypotenuse AB=85, to the greater segment AD 72.4, on the line of numbers, will reach on the sines from the radius 90° to 58° 24' which is the complement of the angle BAD.

3dly. The extent from the hypotenuse CB 57, to the lesser segment DC 35.6 on the line of numbers, will reach on the sines from the radius 90° to 38° 39', which is the complement of the angle BCA.

This case may be solved without dividing the triangle into two right-angled triangles by Theorem V.

To find the angle A.		Having the angle A, we may find the angle C by Theorem II.	
BC= 57		As BC 57	1.75587
AB= 85 log. co. ar.	8.07058	Is to sine angle A 31° 36'	9.71932
AC=108 log. co. ar.	7.96658	So is AB 85	1.92942
Sum 250			
Half sum 125 log.	2.09691		11.64874
Half sum less BC 68 log.	1.83251		1.75587
		To the sine of angle C 51° 23'	9.99287
Sum) 19.96658			
Half sum 15° 48'	Co-sine 9.93329		
2			
Doubled is 31 36=angle A.			

ASTRONOMY AND GEOGRAPHY.

ASTRONOMY is the science which treats of the motions and distances of the heavenly bodies, and of the appearances thence arising.

Geography is the science which treats of the situations and distances of the various parts of the surface of the earth.

The common opinion of astronomers of the present day is, that the universe is composed of an infinite number of systems or worlds; that in every system there are certain bodies moving in free space, and revolving at different distances round a sun, placed in or near the centre of the system; and that these suns and other bodies are the stars which are seen in the heavens.

The **SOLAR SYSTEM**, so called, is that in which our earth is placed, and in which the sun is supposed to be fixed near the centre, with several bodies similar to our earth, revolving round at different distances. This hypothesis, which is fully confirmed by observation, is called the **Copernican System**, from Nicholas Copernicus, a Polish Philosopher, who revived it about the year 1500, after it had been buried in oblivion many ages.

Stars are distinguished into two kinds, *fixed* and *wandering*. The former are supposed to be suns in the centres of their systems, shining with their own light, and preserving nearly the same situation with respect to each other. They are usually distinguished by their brightness, the largest being called of the first magnitude, and the smallest visible to the naked eye being of the sixth or seventh magnitude. A *Constellation* is a number of stars lying in the neighbourhood of one another on the surface of a celestial sphere, which astronomers, for the sake of remembering with greater ease, suppose to be circumscribed by the outlines of some animal or other figure. The *wandering stars* are those bodies within our system, or celestial sphere, which revolve round the sun; they appear luminous by reflecting the light of the sun, and are of three kinds, namely *primary planets*, *secondary planets*, and *comets*.

The *Primary Planets* are bodies which revolve round the sun, as the centre of their courses, the motions being regularly performed in tracks or paths (called *orbits*) that are nearly circular and concentric with each other. A *Secondary Planet*, *Satellite*, or *Moon*, is a body which, while it is carried round the sun, revolves also round a primary planet. *Comets* are a sort of planets moving round the sun in very eccentric orbits, with vast atmospheres about them, and tails derived from the same.

There are eleven primary planets, which, reckoned in order from the sun, are as follows: Mercury, Venus, the Earth, Mars, Vesta, Juno, Pallas, Ceres, Jupiter, Saturn, and Uranus.

Mercury and Venus are called *inferior planets*, because their orbits are within the earth's; the others are called *superior planets*, as their orbits include that of the earth.

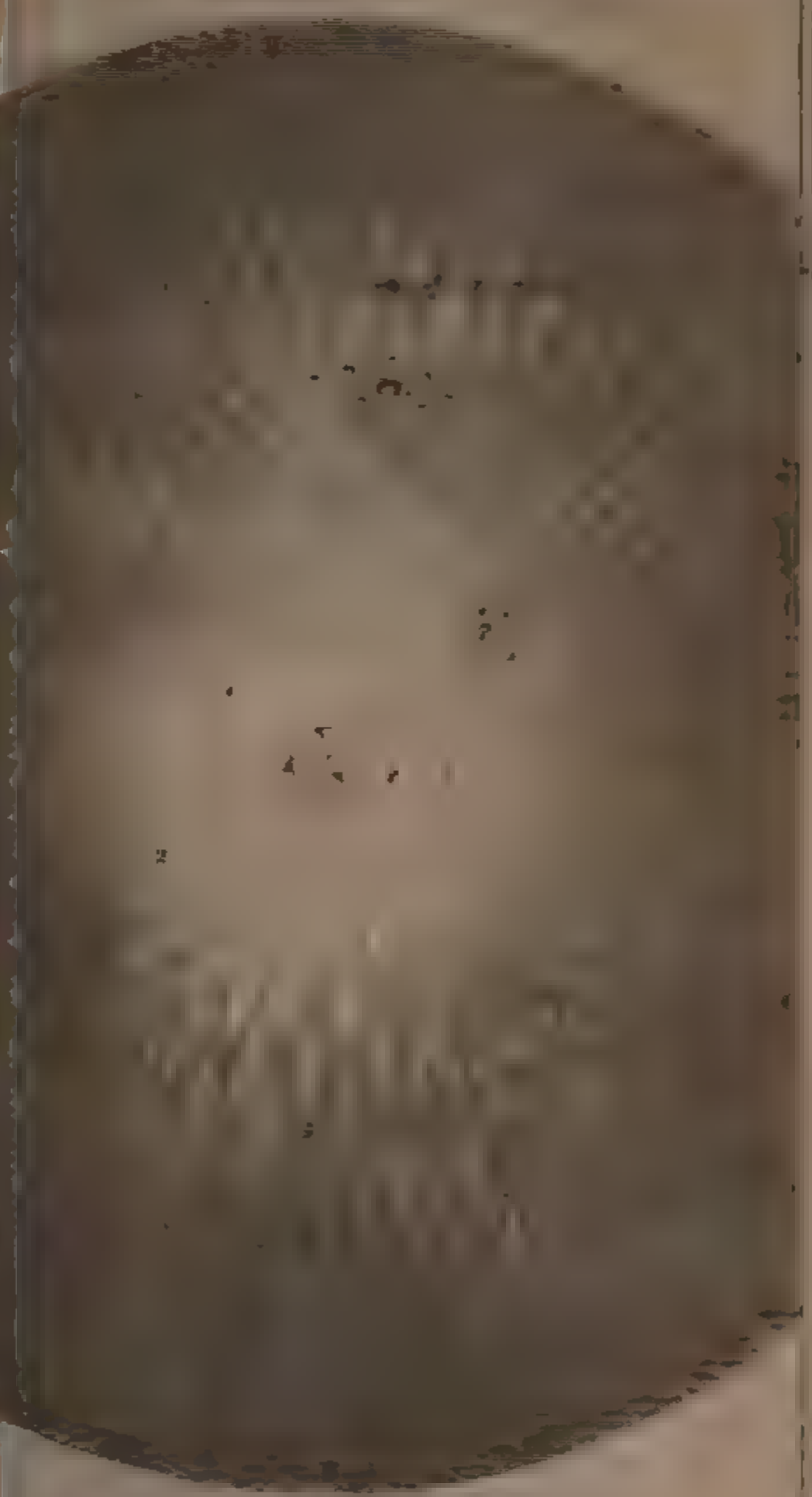
The **SUN**, the first and greatest object of astronomical knowledge, is placed near the centre of the orbits of all the planets, and turns round its axis in 25½ days; its diameter is 883,000 English miles, and its mean distance from the earth 95 millions of miles.

MERCURY is the least of all the planets, known before the discovery of Vesta, Juno, Pallas, and Ceres, and is the nearest to the sun, his mean distance from that luminary being 37 millions of miles. His periodic revolution in his orbit round the sun is performed in 87 days 23 hours, and his diameter is about 3200 miles.

VENUS is the brightest of all the planets. Her diameter is 7687 miles; her mean distance from the sun 68 millions of miles; and her periodic revolution is performed in 224 days 17 hours. When this planet is in that part of her orbit which is west of the sun, she rises before him in the morning, and is called the *morning star*; when she is in the eastern part of her orbit, she shines in the evening, after he sets, and is called the *evening star*.

The next planet is the **EARTH**, the diameter of which is 7964 miles, the from the sun 95 millions of miles, and the time of revolution round

THE SOLAR SYSTEM.



1. The Sun
2. Mercury
3. Venus
4. Earth
5. Mars
6. Jupiter
7. Saturn
8. Uranus
9. Neptune
10. Pluto
11. The Moon
12. The other planets and moons
13. The other planets and moons
14. The other planets and moons
15. The other planets and moons
16. The other planets and moons
17. The other planets and moons
18. The other planets and moons
19. The other planets and moons
20. The other planets and moons
21. The other planets and moons
22. The other planets and moons
23. The other planets and moons
24. The other planets and moons
25. The other planets and moons
26. The other planets and moons
27. The other planets and moons
28. The other planets and moons
29. The other planets and moons
30. The other planets and moons
31. The other planets and moons
32. The other planets and moons
33. The other planets and moons
34. The other planets and moons
35. The other planets and moons
36. The other planets and moons
37. The other planets and moons
38. The other planets and moons
39. The other planets and moons
40. The other planets and moons
41. The other planets and moons
42. The other planets and moons
43. The other planets and moons
44. The other planets and moons
45. The other planets and moons
46. The other planets and moons
47. The other planets and moons
48. The other planets and moons
49. The other planets and moons
50. The other planets and moons
51. The other planets and moons
52. The other planets and moons
53. The other planets and moons
54. The other planets and moons
55. The other planets and moons
56. The other planets and moons
57. The other planets and moons
58. The other planets and moons
59. The other planets and moons
60. The other planets and moons
61. The other planets and moons
62. The other planets and moons
63. The other planets and moons
64. The other planets and moons
65. The other planets and moons
66. The other planets and moons
67. The other planets and moons
68. The other planets and moons
69. The other planets and moons
70. The other planets and moons
71. The other planets and moons
72. The other planets and moons
73. The other planets and moons
74. The other planets and moons
75. The other planets and moons
76. The other planets and moons
77. The other planets and moons
78. The other planets and moons
79. The other planets and moons
80. The other planets and moons
81. The other planets and moons
82. The other planets and moons
83. The other planets and moons
84. The other planets and moons
85. The other planets and moons
86. The other planets and moons
87. The other planets and moons
88. The other planets and moons
89. The other planets and moons
90. The other planets and moons
91. The other planets and moons
92. The other planets and moons
93. The other planets and moons
94. The other planets and moons
95. The other planets and moons
96. The other planets and moons
97. The other planets and moons
98. The other planets and moons
99. The other planets and moons
100. The other planets and moons

the sun one year. The earth turns round its axis from west to east in 23h. 56m. which occasions the apparent diurnal motion of the sun and all the heavenly bodies round it from east to west in the same time, and is, of course, the cause of their rising and setting, of day and night. The axis of the earth is inclined about $23^{\circ} 28'$ to the plane of its orbit,* and keeps nearly in a direction parallel to itself, throughout its annual course, which causes the return of spring and summer, autumn and winter. Thus the diurnal motion gives us the grateful vicissitude of night and day, and the annual motion the regular succession of the seasons. The earth is attended by a satellite called the Moon, whose diameter is 2161 miles; her distance from the centre of the earth is 240,000 miles: she goes round her orbit in 27 days 8 hours; but, reckoning from change to change, in 29½ days. Her orbit is inclined to the ecliptic in an angle of $5^{\circ} 9'$, cutting it in two points diametrically opposite to each other, called her nodes. As the moon shines only by the reflected light of the sun, she must appear different when in different situations with respect to that luminary. When she is in conjunction with the sun, her dark side is turned towards the earth, which renders her invisible; this is called *new moon*: when she is in opposition, her light side is wholly visible from the earth; this is called *full moon*.

If at the time of new moon she is near to either of her nodes, she may intercept a part of the sun's light, and thus cause an *eclipse of the sun*; and if she is near either of her nodes at the time of full moon, she may pass into the shadow of the earth, and cause an *eclipse of the moon*. In a similar manner, when the moon passes between an observer on the earth and a star, it is called an *Occultation* of the star. The instant when the moon's limb first covers the star is called the *Immersion*, and the moment of its re-appearance is called the *Emergence*. When Mercury or Venus passes between the sun and an observer, and appears to pass over the sun's disk, it is called a *Transit* of Mercury or Venus. Eclipses, Occultations and Transits, are of great importance in ascertaining the longitudes of places on the earth. Eclipses of the moon furnish a convincing proof of the rotundity of the earth, since the shadow of the earth, seen upon the moon when eclipsed, is always circular. This is farther confirmed by the appearance of objects at sea; for when a ship is making towards the land, the mariners first descry the tops of steeples, trees, &c. pointing above the water; the lower parts being hid, by reason of the curvature of the earth.

The earth is not a perfect globe or sphere, but is a little flattened at the poles, being nearly of the figure of an oblate spheroid, the equatorial diameter being about 26 miles longer than the polar: but since this difference bears but a small comparison to the whole diameter, we may, for all the practical purposes of navigation, consider the earth as a perfect sphere, as will be done in the rest of this work. The natural divisions of the earth will be given hereafter.

Mars is the next planet to the earth; his diameter is 4189 miles, his distance from the sun 144 millions of miles, and his periodic revolution is performed in about 687 days. He revolves round his axis in 24 hours 40 minutes, appearing of a dusky reddish hue, and is supposed to be encompassed with a very great atmosphere.

Between Mars and Jupiter are situated the four lately discovered planets, Vesta, Juno, Pallas, and Ceres, named Asteroids by Doctor Herschel. The elements of their orbits have not been accurately ascertained, but are nearly as the following description.

VESTA was discovered by Doctor Olbers of Bremen, on the 29th of March, 1807. Its mean distance from the sun is about 205 millions of miles; its periodic revolution is performed in about 8 1-6 years.

JUNO was discovered by Mr. Harding, of Lilienthal (near Bremen) on the 1st of September, 1804. It appears like a star of the eighth magnitude. Its distance from the sun is about 255 millions of miles; its periodic revolution is performed in 1582 days. The inclination of its orbit to the ecliptic is $15^{\circ} 50'$ and the eccentricity of the orbit 0.25 .

* The inclination decreases at present about $50''$ in 100 years, by reason of the attraction of the planets on the earth. It is also affected by the Disturbance given in Table XLIII. which sometimes amounts to $9'$. In computing the eccentricities of the planets their mean distance from the sun is put equal to unity.

PALLAS, was also discovered by Dr. Olbers, March 28, 1802. Its diameter, according to Doctor Herschel, is only 110 miles; it appears like a star of the eighth magnitude. Its mean distance from the sun is about 266 millions of miles. Its periodic revolution is performed in 1683 days. The inclination of its orbit to the ecliptic is $34^{\circ} 39'$ and the eccentricity of the orbit 0.2463.

CERES, was discovered by Mr. Piazzi of Palermo on the first of January, 1801. Its diameter, according to Dr. Herschel, is only 160 miles. It appears like a star of the seventh or eighth magnitude. Its distance from the sun is about 266 millions of miles, and its periodic revolution is performed in 1683 days, being at nearly the same distance from the sun as Pallas. The inclination of the orbit of Ceres to the ecliptic is $10^{\circ} 37'$ and the eccentricity 0.097. The situations of the nodes of the two planets Ceres and Pallas, and the inclinations of their orbits, are very different from each other, so that when those planets are in the same plane, they are at a great distance from each other, notwithstanding their mean distances from the sun are nearly equal. It has been supposed by some, that these small bodies are fragments of a former planet.

JUPITER is situated still higher in the system, and is the largest of all the planets, being easily distinguished from them by his peculiar magnitude and light. His diameter is 89,170 miles, his distance from the sun 490 millions of miles, and the time of his periodic revolution is 4332 $\frac{1}{2}$ days. Though Jupiter is the largest of all the planets, yet his diurnal revolution is the swiftest, being only 9 hours and 56 minutes.

Jupiter is attended by four satellites, invisible to the naked eye, but through a telescope they make a beautiful appearance. In speaking of them, we distinguish them according to their places, into the first, second, and so on; by the first we mean that which is nearest to the planet. The appearance of these satellites is marked in the XIIth. page of the Nautical Almanac, for some particular hour of the night; the times when they are eclipsed, by passing into the shadow of Jupiter, are also given in the Nautical Almanac; these eclipses are of considerable use in determining the longitudes of places on the earth.

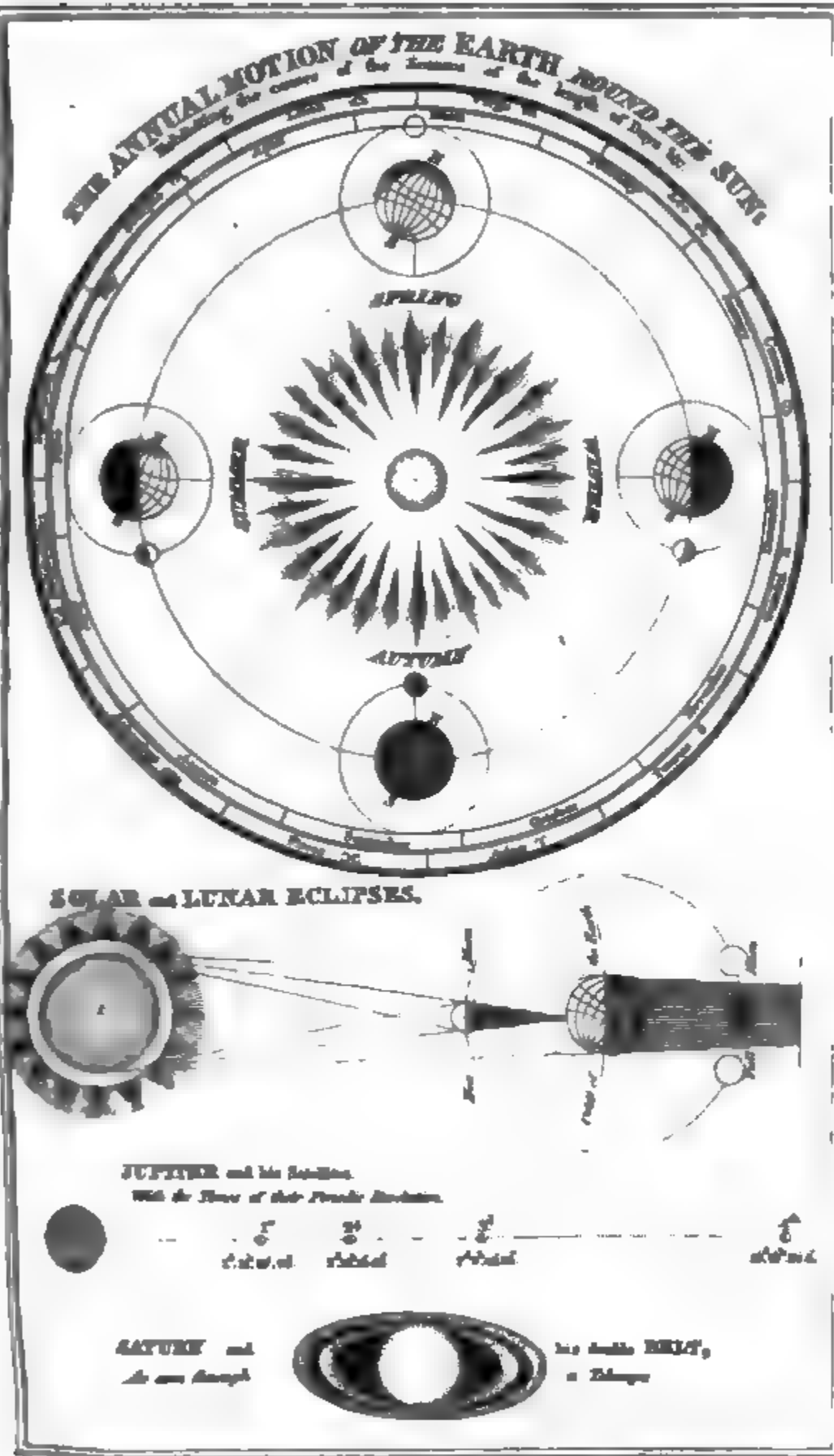
Before the discovery of the planet Uranus, **SATURN** was reckoned the most remote planet of our system. He shines with but a pale and feeble light. His diameter is 79,042 miles, his distance from the sun 900 millions of miles, and his periodic revolution in his orbit is performed in about 29 years 167 days. This planet is surrounded with a broad flat ring, has a diurnal revolution round its axis, and is attended by seven satellites.

By some observations made by Dr. Herschel, it appeared that the largest diameter of Saturn corresponds to the latitude of 45° , but from later observations he has been induced to believe, that this irregularity is owing to an optical deception, arising from the refraction of the light in passing through the atmosphere of the ring.

URANUS, Herschel, or Georgium Sidus, is the most remote planet of our system. It was discovered in the year 1781, by Dr. Herschel, though it had been seen several times, but had been considered as a fixed star. Its diameter is 35,109 miles, its distance from the sun 1800 millions of miles, and its periodic revolution in its orbit is performed in 83 $\frac{1}{2}$ years. Dr. Herschel has also discovered six satellites attending this planet.

The astronomy of comets is yet in its infancy. The return of one of them in the year 1758 was foretold by Dr. Halley, and it happened nearly as he predicted. He also foretold the return of another in the year 1790, but it never appeared. This was owing to the inaccuracy of the observations of the comet at its former appearance; for Mr. Mechain, having collected all the observations, and calculated the orbit again, found it to differ essentially from that determined by Dr. Halley. Olber's comet, which appeared in 1815, has a revolution of 72 years; and Encke's comet, which has been observed in several successive approaches to the perihelion, completes its revolution in the short period of 1204 days.

Comets move round the sun in all directions, but the planets and satellites, except one of the satellites of Uranus, move from west to east when seen from the sun; but if viewed from any other of the planets, as the earth, they would appear to revolve round it as a centre; but the sun would be the only one that moved uniformly the same way, for the other planets would some-



times appear to move from west to east, and then to stand still; then they would seem to move from east to west; and after standing some time, they would again move from west to east; and so on continually. The motion of a planet from west to east is called the *direct* motion, or *according to the order of the signs*. The contrary motion from east to west, is called *retrograde*. When the planet appears to stand still, it is said to be *stationary*.

To illustrate what has already been said relative to the motions and distances of the planets and satellites, we have given the adjoining Plates III. and IV. which require no explanation.

In noting the situations of the stars and planets, astronomers have been under the necessity of imagining various lines and circles on the sphere; and geographers have done the same for fixing the situation of places on the earth. The most remarkable of these are the following.

A *great circle* is that whose plane passes through the centre of the sphere; and a *small circle* is that whose plane does not pass through that centre.

A diameter of a sphere, perpendicular to any great circle, is called the *axis* of that circle; and the extremities of a diameter are called its *poles*. Hence the pole of a great circle is 90° from every point of it upon the surface of the sphere; but as the axis is perpendicular to the circle when it is perpendicular to any two radii, a point on the surface of a sphere 90° distant from any two points of a great circle will be the pole.

All angular distances on the surface of a sphere, to an eye at the centre, are measured by arcs of *great circles*. Hence all triangles formed upon the surface of a sphere, for the solution of spherical problems, must be formed by the arcs of great circles.

Secondaries to a great circle are great circles which pass through its poles, and consequently must be perpendicular to their great circles.

The *axis* of the earth is that diameter about which it performs its diurnal motion; and the extremities of this diameter are called the poles.

The *terrestrial equator* is a great circle of the earth perpendicular to its axis. Hence the axis and poles of the earth are the axis and poles of its equator. That half of the earth which lies on the side of the equator, in which Europe and the United States of America are situated, is called the *northern hemisphere*, and the other the *southern*; and the poles are respectively called the *north* and *south* poles.

The *latitude* of a place upon the earth's surface is its angular distance from the equator, measured upon a secondary to it. These secondaries to the equator are called *meridians*.

The *longitude* of a place on the earth's surface is an arc of the equator intercepted between the meridian passing through the place, and another, called the *first meridian*, passing through that place from which you begin to measure, or it is the angle formed at the pole by these two meridians. The Americans and English generally place the first meridian at London or Greenwich, the French place it at Paris, the Spaniards at Cadiz; some Geographers place it at Teneriffe, and others at other places. Throughout this work Greenwich will be reckoned as the first meridian. The longitude is counted from the first meridian, both eastward and westward, till it meets at the same meridian on the opposite point; therefore the longitude (and also the difference of longitude between any two places) can never exceed 180° .

If the plane of the *terrestrial equator* be produced to the sphere of the fixed stars, it marks out a circle called the *celestial equator*; and if the axis of the earth be produced in like manner, the points of the heavens, to which it is produced, are called poles, being the *poles* of the celestial equator. The star nearest to each pole is called the *pole star*.

Secondaries to the celestial equator are called *circles of declination*; of these 24, which divide the equator into equal parts, each containing 15° , are called *hour circles*.

Small circles parallel to the celestial equator are called *parallels* of declination.

The *sensible horizon* is that circle in the heavens whose plane touches the earth at the spectator. The *rational horizon* is a great circle in the heavens, passing through the earth's centre, parallel to the sensible horizon.

If the radius drawn from the centre of the earth to the place where the spectator stands be produced both ways to the heavens, the point vertical to him is called the *zenith*, and the point opposite, the *nadir*. Hence the *zenith* and *nadir* are the poles of the rational horizon.

Secondaries to the horizon are called *vertical* circles, because they are perpendicular to the horizon. On these circles, therefore, the altitude of a heavenly body is measured.

The secondary common to the celestial equator, and the horizon of any place, is the *celestial meridian* of that place. This meridian corresponds with the *terrestrial meridian* of the same place, which passes through the poles of the earth, the zenith and nadir crossing the equator at right angles, and cutting the horizon in the north and south points; that point being called *north* which passes through the north pole, and the opposite direction is called *south*. The vertical circle which cuts the meridian of any place at right angles is called the *prime vertical*; the points where it cuts the horizon are called the east and west points, and to an observer, with his face directed towards the south, the east point will be to his left hand, and the west to his right hand. Hence the east and west points are 90° distant from the north and south. These four are called the *cardinal* points. The meridian of any place divides the heavens into two hemispheres lying to the east and west; that lying to the east is called the *eastern* hemisphere, and the other the *western* hemisphere. When the sun is at its greatest altitude on the meridian of any place, it is noon or mid-day.

The *azimuth* of an heavenly body is its distance on the horizon, when referred to it by a secondary, from the north or south points. The *amplitude* is its distance from the east or west points, at the time of rising or setting.

The *ecliptic* is that great circle in the heavens which the sun appears to describe in the course of a year. The ecliptic and equator, being great circles, must bisect each other, and their angle of inclination is called the *obliquity of the ecliptic*; and the points where they intersect are called the *equinoctial points*. The times when the sun comes to these points are called the *equinoxes*. The ecliptic is divided into 12 equal parts, called *signs*:—viz. Aries γ , Taurus δ , Gemini Π , Cancer σ , Leo Ω , Virgo \mathbb{M} , Libra \neq , Scorpio \mathcal{M} , Sagittarius \dagger , Capricornus \mathcal{V} , Aquarius \approx , Pisces \propto . The order of these is according to the apparent motion of the sun. The first point of Aries coincides with one of the equinoctial points, and the first point of Libra with the other. The first six signs are called *northern*, lying on the north side of the equator; and the last six are called *southern*, lying on the south side.

The *zodiac* is a space extending eight degrees on each side the ecliptic, within which the motion of all the planets is contained, except the newly discovered planets.

The *right ascension* of a body is an arc of the equator intercepted between the first point of Aries and a circle of declination passing through the body, measured according to the order of the signs.

Right ascension of the meridian or mid-heaven, is the distance of the meridian, from the first point of Aries, and is found by adding the apparent time past noon, to the sun's right ascension.

The *ascensional difference* of any object is the difference between the right ascension of the object and that point of the equator which rises or sets with it.

The *declination* of a star or any celestial object is its angular distance from the equator, measured upon a secondary to it passing through the object.

The *longitude* of a star or any celestial object is an arc of the ecliptic intercepted between the first point for Aries and a secondary to the ecliptic passing through the body, measured according to the order of the signs.—If the observer be on the earth, the longitude is called the *geocentric* longitude; but if seen from the sun it is called the *heliocentric* longitude; the body in each case being referred perpendicularly to the ecliptic in a plane passing through the eye.

Nonagesimal degree of the ecliptic is its highest point at any given time, and is 90° from the points where the ecliptic intersects the horizon.

The *latitude* of a star or any celestial object is its angular distance from the ecliptic, measured upon a secondary to it drawn through the body.—If the body be observed from the earth, its angular distance from the ecliptic is called the *geocentric* latitude; but if observed from the sun it is called the

heliocentric latitude. The secondary circle drawn perpendicular to the ecliptic is called a *circle of latitude*.

The *tropics* are two parallels of declination touching the ecliptic. One, touching it at the beginning of cancer, is called the *tropic of cancer*; and the other, touching it at the beginning of capricorn, is called the *tropic of capricorn*. The two points, where the tropics cut the ecliptic, are called the *solstitial points*.

Colures are two secondaries to the celestial equator, one passing through the equinoctial points, called the *equinoctial colure*; and the other passing through the solstitial points, are called the *solstitial colure*. The times when the sun comes to the solstitial points are called the *solstices*.

Aberration of a star or any heavenly body, is a small apparent motion, occasioned by the progressive velocity of light. This is calculated by means of Tables XXXIX. XLI. or XLII.

Nutation is a small apparent motion of the heavenly bodies, occasioned by a real motion of the earth's axis, arising from the attractions of the sun and moon on the spheroidal form of the earth. The effect of this on the right ascension and declination is given in Table XLIII. and on the longitude in Table XL. The correction in this last Table being generally called the equation of the equinoxes in longitude.

Precession of the equinoctial points is a small motion of about 50" per year, occasioned by the same cause as the nutation. By this motion the equinoctial points are carried backward from east to west; consequently, the heavenly bodies appear to move forward the same quantity from west to east. The annual variations of the places of the stars from precession, and the secular equations arising from the change of the earth's orbit by the attraction of the planets, are given in Tables VIII. and XXXVII.

The *arctic* and *antarctic* circles are two parallels of declination, the former about the north, and the latter about the south pole, the distance of which from the two poles is equal to the distance of the tropics from the equator, which is about $23^{\circ} 28'$. These are also called *polar circles*. The two tropics and two polar circles, when referred to the earth, divide it into five parts, called *zones*; the two parts within the polar circles are called the *frigid zones*; the two parts between the polar circles and tropics are called the *temperate zones*; and the part between the tropics is called the *torrid zone*.

Besides the imaginary divisions of the earth, there are various natural divisions of its surface, formed by nature, such as continents, oceans, islands, seas, rivers, &c.

A *Continent* is a large tract of land, wherein are several empires, kingdoms, and countries conjoined—as Europe, Asia, Africa, and America.

An *Island* is a part of the earth that is environed or encompassed round by the sea, as Long Island, Block Island, &c.

A *Peninsula* is a portion of land almost surrounded with water, save one narrow neck which joins it to the continent, as the Morea.

An *Isthmus* is a narrow neck of land joining a peninsula to the adjacent land, by which the people may pass from one to the other, as the isthmus of Darien.

A *Promontory* is a high part of land stretching itself into the sea, the extremity of which is called a Cape or Headland.

A *Mountain* is a rising part of dry land, over-topping the adjacent country, and appearing first at a distance.

An *Ocean* is a vast collection of water, separating continents from one another, and washing their borders or shores, as the Atlantic and Pacific Oceans.

A *Sea* is part of the ocean, to which we must sail through some strait, as the Mediterranean and Baltic seas. This term is sometimes used for the whole body of salt water on the globe.

A *Strait* is a narrow part of the ocean lying between two shores, and opening a way into some sea, as the Straits of Gibraltar that lead into the Mediterranean Sea.

A *Creek* is a small narrow part of the sea or river, that goes up but a little way into the land.

A *Bay* is a great inlet of the land, as the Bay of Biscay, and the Bay of Mexico; otherwise a bay is a station or road for ships to anchor in.

A *River* is a considerable stream of water issuing out of one or various springs, and continually gliding along in one or more channels, till it discharges itself into the ocean: the lesser streams are called rivulets.

A *Lake* is a large collection of waters in an inland place, as the lakes Superior and Huron in America.

A *Gulf* is a part of the ocean or sea, nearly surrounded by the land, except where it communicates with the sea, as the Gulf of Venice.

Thus we have given the most useful definitions of Astronomy and Geography, and to assist the learner there is also given Plate V. in which those terms are explained at one view. We may farther observe, that as the latitude of any place upon the earth is counted from the equator upon an arch of the meridian, the difference of latitude between two places, both north, or both south, is found by *subtracting the less latitude from the greater; but if one latitude be north, and the other south, the difference is found by adding both latitudes together.*

1. Consequently, if a ship in north latitude sails northerly, or in south latitude southerly, she increases her latitude; but in north latitude sailing southerly, or in south latitude sailing northerly, she decreases her latitude, because she sails nearer to the equator, from whence the latitude is reckoned.

2. Wherefore, in north latitude sailing northerly, or in south latitude sailing southerly, the difference of latitude, added to the latitude left, gives the latitude in.

3. In north latitude sailing southerly, or in south latitude sailing northerly, the difference of latitude, subtracted from the latitude left, gives the latitude in.

4. When the latitude decreases, and the difference of latitude is greater than the latitude sailed from, subtract the latitude left from the difference of latitude, and the remainder will be the latitude in, but of a different name, for it is evident in this case, that the ship has crossed the equator.

5. The difference of longitude between two places, being both east or west, is found by *subtracting the less longitude from the greater: but if one be east longitude and the other in west, their sum is the difference of longitude when it does not exceed 180°, but if it exceeds 180°, that sum must be subtracted from 360°, and the remainder will be the difference of longitude.*

6. Therefore in east longitude sailing easterly, or in west longitude sailing westerly, the difference of longitude added to the longitude left, gives the longitude in, when that sum does not exceed 180°; but if it exceeds 180°, the sum, subtracted* from 360°, leaves the longitude in, but of a different name from that left.

7. In east longitude sailing westerly, or in west longitude sailing easterly, the difference of longitude, subtracted from the longitude left, gives the longitude in, but when the difference of longitude is greatest, the longitude left must be subtracted from that difference, and the remainder will be the longitude in, but of a different name from the longitude left.

What has been said will be rendered familiar to the learner by the following examples.

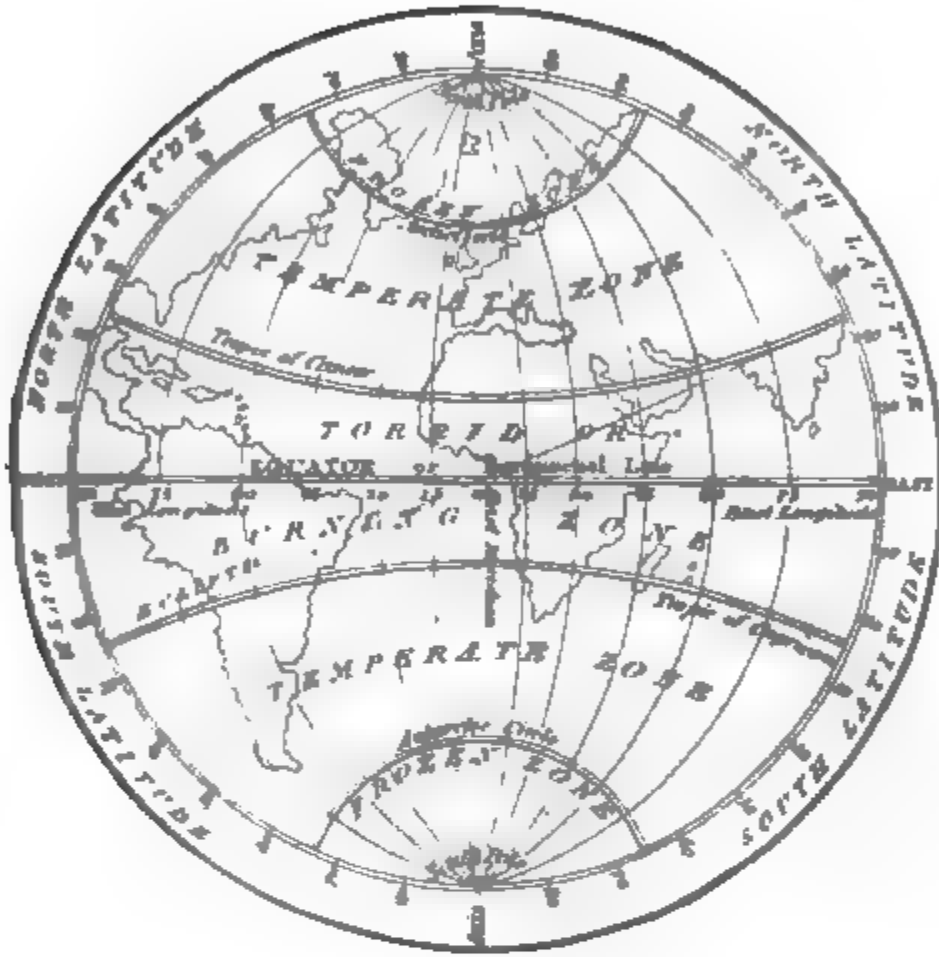
EXAM. I. What is the difference of latitude between Boston, in the latitude of 42° 23' N. and Richmond (Virginia) in the lat. of 37° 30' N.?		EXAM. II. A ship from latitude 59° 27' sails southward until her difference latitude is 374 miles; what latitude is she come to?	
From Boston's lat.	42° 23' N.	Latitude sailed from	59° 27' N
Subtract Richmond's lat.	37 30 N.	Diff. of lat. 374÷60=	6 14 N
	<hr/>		<hr/>
Remains the diff. of lat.	4 53	Lat. in	65 41 N
	60		
	<hr/>		
In Miles	293		

* In this rule it is supposed, that the sum of the longitude left, and the difference of longitude, is less than 360°, which is always the case when the difference of longitude is less than 180°, which we are generally supposed to be the case in these rules.

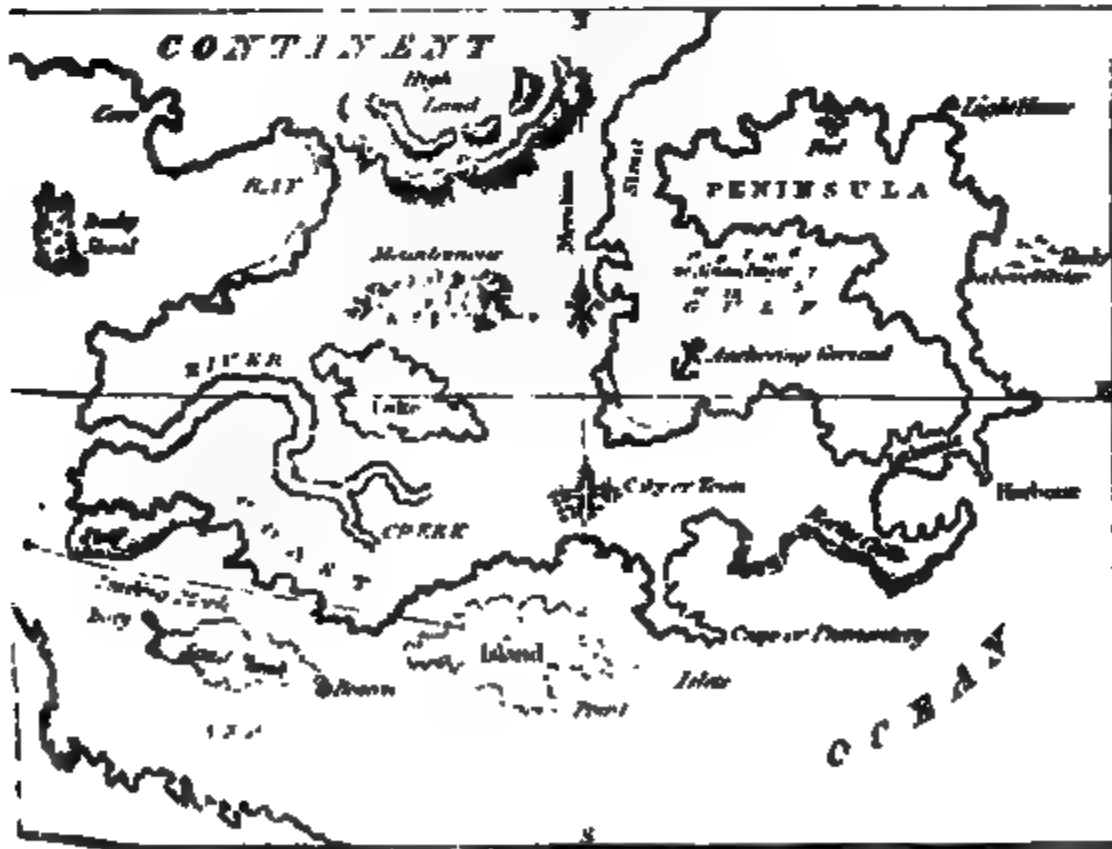


Plate V.

**THE CIRCLES, ZONES, &c. OF
THE ARTIFICIAL GLOBE OR SPHERE**



EXPLANATION OF GEOGRAPHICAL TERMS.



The Art. Eng.

Ex. III. Required the difference of latitude between Georgetown and Cape Frio?

Georgetown's lat.	33° 25' N.
Cape Frio's lat.	23 1 S.
Diff. of lat.	56 24
	60
In miles	3384

In the last example it is evident that as the difference of latitude is more than the latitude left, the ship must have crossed the equator, and consequently come into south latitude.

NOTE. When one of the places has no latitude, or is on the equator, the latitude of the other place is their difference of latitude.

Ex. V. What is the difference of longitude between Cape Ann light-house and Lisbon?

Cape Ann light-house's long.	70° 34' W.
Lisbon's long.	9 9 W.
Diff. of long.	61 25
	60
In miles	3685

Ex. VII. What is the difference of longitude between Barcelona and Salem?

Barcelona's long.	2° 12' E.
Salem's long.	70 52 W.
Diff. of long.	73 4 W.

Ex. IX. What is the difference of longitude between Manilla and New-York light-house?

Manilla's long.	121° 02' E.
New-York light-house	74 01 W.
Sum exceeds 180°	195 03
Subtract it from	360 00
Diff. of long.	164 57

Ex. IV. A ship from latitude 28° 25' N. sails south 1800 miles; what latitude is she in?

From diff. of lat. 1800 miles, or	30° 00' S.
Sub. lat. left	28 25 N.
Diff. = lat. in	1 35 S.

Ex. VI. A ship from Cape Charles, in Virginia, sails eastward till her difference of longitude is 400 miles; what longitude is she in?

Cape Charles' long.	76° 04' W.
Diff. of long. 400 miles =	6 40 E.
Long. in	69 24 W.

Ex. VIII. A ship from 15° 40' E. long. sails westward till her diff. of long. is 27° 15', what longitude is she in?

Long. left	15° 40' E.
Diff. of long.	27 15 W.
Long. in	11 35 W.

Ex. X. A ship from longitude 160° 20' W. sails westward until she differs her longitude 41° 20'; what longitude is she in?

Long. left	160° 20' W.
Diff. of long.	41 20 W.
	201 40
	360 00
Long. in	158 20 E.

In the last example the ship has crossed the opposite meridian, and therefore has come into a longitude of a different name.

PLANE SAILING.

PLANE SAILING is the art of navigating a ship upon principles deduced from the supposition of the earth's being an extended plane, on which the meridians are all parallel to each other.* A map of the several parts of the earth, constructed upon these principles, is called a PLANE CHART. When the parts of the earth are thus delineated on a plane, it is easy to see the track by which a ship may go from one place to another, and also what angle this track makes with the meridian.† Ships at sea are kept in this track by means of an instrument called the mariner's compass.

The MARINER'S Compass is an artificial representation of the horizon of any place. It consists of a circular piece of paper (see Plate VI. fig. 1) called a card, divided (like the horizon) into 360 degrees or 32 points. This is fixed on a piece of steel, called a needle, to which the magnetic virtue has been communicated by means of a loadstone, which has the property of pointing steadily towards the north, and carrying the card with it, when turning freely on a pivot or any thing to support it. Thus all the points of the card will be

* The explanations of Plane Sailing, and the definitions of this page (and in the former editions of this work) are nearly the same as those given by Moore, in his Practical Navigator; by Robertson in his Elements of Navigation, and by most writers on Navigation.

† The method of calculating this angle on the true principles of sailing on the spherical surface of the earth, will be given hereafter.

directed towards their corresponding points of the horizon,* consequently, by help of the compass a ship may be kept in any proposed track or course.

The **COURSE** is the angle which the line described by a ship makes with the meridian, being sometimes reckoned in points, half points, &c. and sometimes in degrees.

DISTANCE is the way or length a ship has gone on a direct course in a given time. The method of measuring this distance by the log will be explained hereafter.

DIFFERENCE OF LATITUDE is the distance which the ship has made north or south of the place sailed from, or the portion of the meridian contained between the parallels of latitude sailed from and come to.

DEPARTURE is the east or west distance a ship has made from the meridian, or the whole easting or westing made by the ship.

If a ship sails due north or south, she sails on a meridian, makes no departure, and her distance and difference of latitude are the same. If she sails due east or west, she goes on a parallel of latitude, makes no difference of latitude, and her departure and distance are the same.

The difference of latitude and departure make the legs of a right-angled triangle, the hypotenuse of which is the distance the ship has sailed; the perpendicular is the difference of latitude counted on the meridian; the base is the departure, which is easting or westing counted from the meridian; the angle opposite to the base is the course, or angle, that the ship makes with the meridian; and the angle opposite the perpendicular is the complement of the course, which being taken together, make always 8 points or 90 degrees.

In constructing figures relating to a ship's course, let the upper part of the paper, or what the figure is drawn upon, always represent the north; the lower part will be the south; the right hand east, and the left west.

Draw the north and south line to represent the meridian of the place the ship sails from; then, if the ship's course is to the southward, mark the upper end of the line for the place sailed from; but if the course is northward, mark the lower end for that place.

When the course is easterly, describe the arch, and lay off the course and departure on the right hand side of the meridian; but when westerly, on left hand side.

When the course is given in degrees, they must be taken from the line of chords; but when in points, from the line of rhumbs, and must always be laid off upon the arch, beginning at the meridian.

When the course is given in points, the log-sine, log. co-sine, &c. may be found in Table XXV. otherwise in Table XXVII.

In all cases, where the complement of course, or co-sine, &c. is used, the degrees or points put down, are the course itself, but the logarithms belonging to the complement or co-sine, &c. of that course are taken.

Table of the Angles which every Point of the Compass makes with the Meridian.

North.	South.	Point.	D. M.	North.	South.
		$\frac{1}{4}$	2.49		
		$\frac{1}{2}$	5.37		
		$\frac{3}{4}$	8.26		
N. by E.	S. by E.	1	11.15	N. by W.	S. by W.
		$1\frac{1}{4}$	14. 4		
		$1\frac{1}{2}$	16.52		
		$1\frac{3}{4}$	19.41		
N. N. E.	S. S. E.	2	22.30	N. N. W.	S. S. W.
		$2\frac{1}{4}$	25.19		
		$2\frac{1}{2}$	28. 7		
		$2\frac{3}{4}$	30.56		
N. E. by N.	S. E. by S.	3	33.45	NW. by N.	S. W. by S.
		$3\frac{1}{4}$	36.34		
		$3\frac{1}{2}$	39.22		
		$3\frac{3}{4}$	42.11		
N. E.	S. E.	4	45. 0	N. W.	S. W.
		$4\frac{1}{4}$	47.49		
		$4\frac{1}{2}$	50.37		
		$4\frac{3}{4}$	53.26		
N. E. by E.	S. E. by E.	5	6.15	NW. by W.	SW. by S.
		$5\frac{1}{4}$	59. 4		
		$5\frac{1}{2}$	61.52		
		$5\frac{3}{4}$	64.41		
E. N. E.	E. S. E.	6	67.30	W. N. W.	W. S. W.
		$6\frac{1}{4}$	70.19		
		$6\frac{1}{2}$	73. 7		
		$6\frac{3}{4}$	75.56		
E. by N.	E. by S.	7	78.45	W. by N.	W. by S.
		$7\frac{1}{4}$	81.34		
		$7\frac{1}{2}$	84.22		
		$7\frac{3}{4}$	87.11		
	East.	8	90. 0	West.	

* It is here supposed that the needle points to the true north, but if it varies therefrom, allowance must be made for the variation by the rules which will be given in this work.

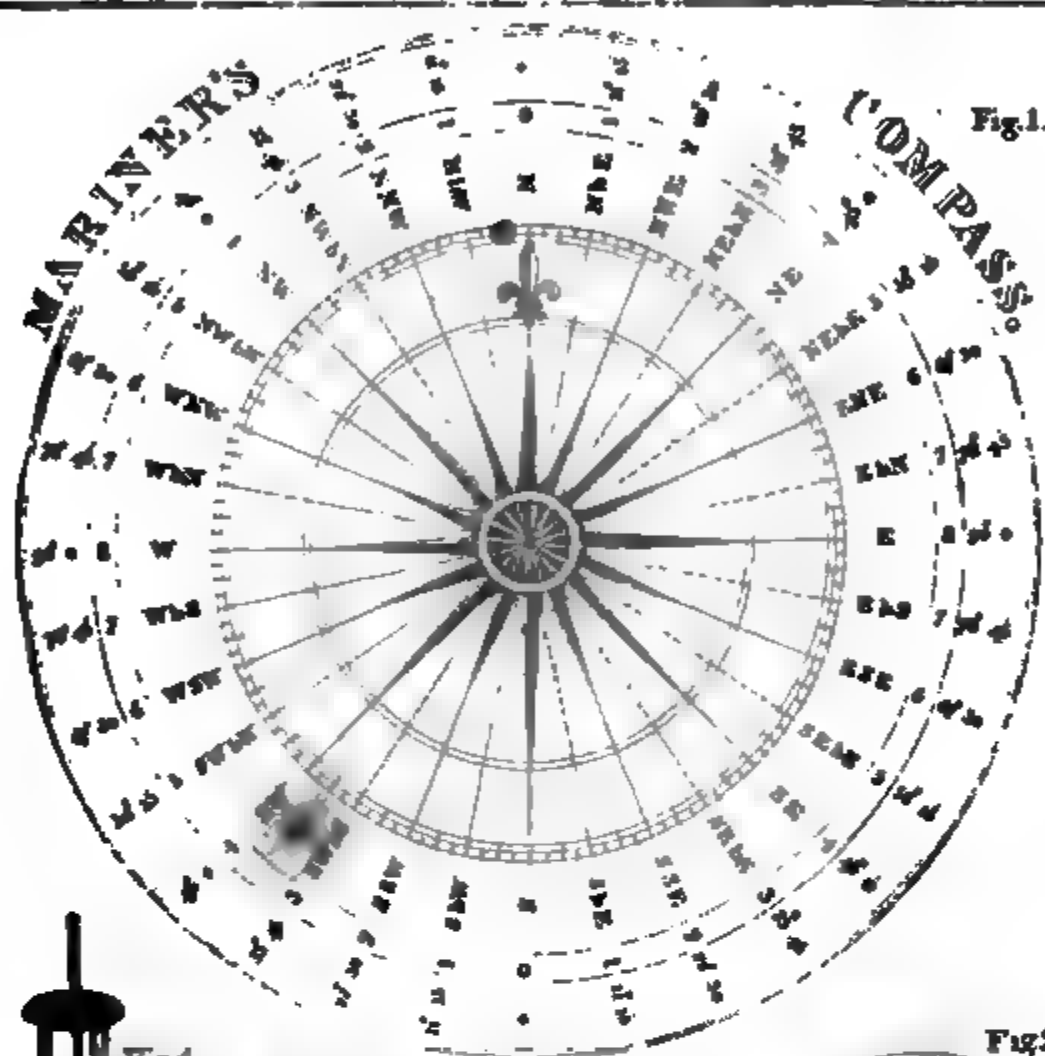


Fig. 1.



Fig. 4.



Fig. 3.



Fig. 2.



Fig. 5.

AZIMUTH

COMPASS.

PLANE SAILING.

25

In the following Table, the rules for solving the various cases of Plane Sailing are collected.

PLANE SAILING.

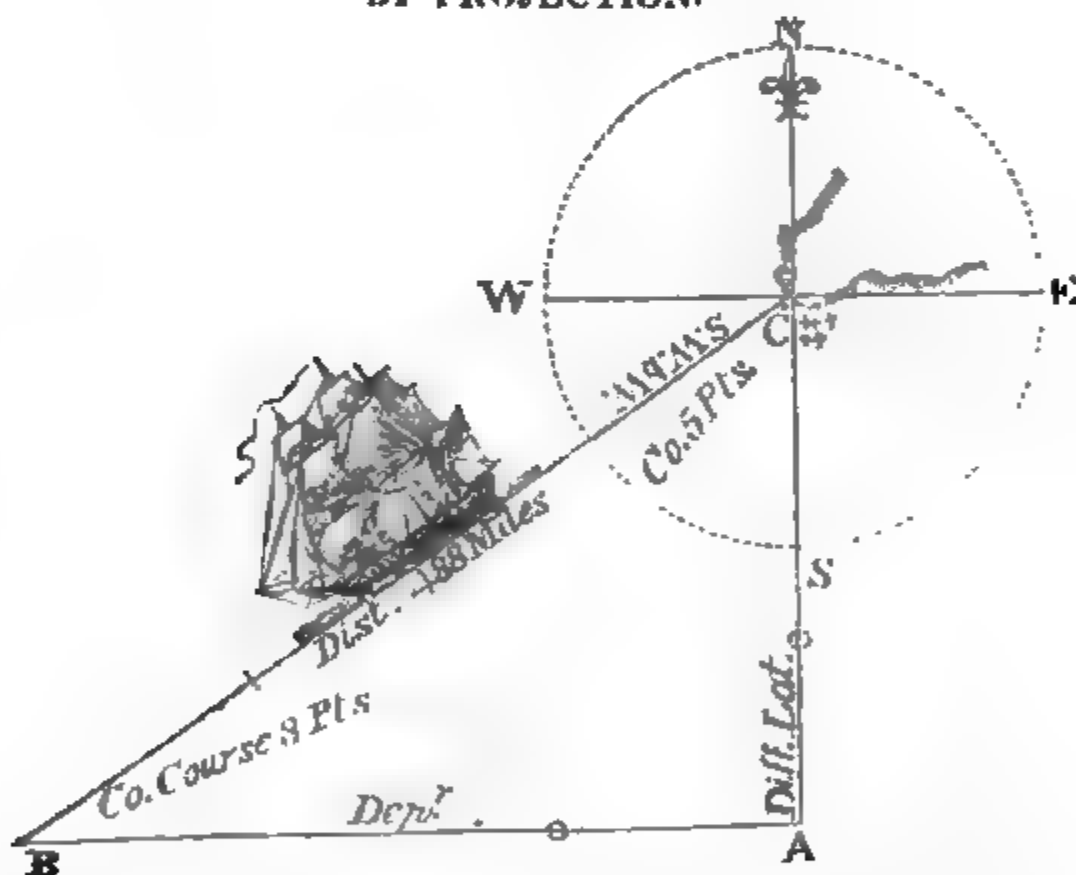
Case	Given	Required	Solutions			
1	Course and Distance	Diff. of Lat. Departure	Rad. Dist.	Rad. Dist.	Co-sine Course	Diff. of Lat. Departure
2	Course and Diff. of Lat.	Distance Departure	Co-sine Course	Diff. Lat.	Rad.	Distance
3	Course and Distance	Distance Departure	Radius	Diff. Lat.	Tang. Course	Departure
4	Distance and Diff. of Lat.	Course Departure	Sine Course	Departure	Rad.	Distance
5	Distance and Course	Diff. of Lat.	Radius	Departure	Co-tang. Course	Diff. Lat.
6	Distance and Diff. of Lat.	Course Departure	Distance	Radius	Diff. Lat.	Co-sine Course
7	Distance and Course	Diff. of Lat.	Radius	Distance	Sine Course	Departure
8	Diff. of Lat. and Departure	Course Distance	Distance	Radius	Departure	Sine Course
9	Diff. of Lat. and Departure	Course Distance	Radius	Distance	Co-sine Course	Diff. Lat.
10	Diff. of Lat. and Departure	Course Distance	Diff. Lat.	Radius	Dep.	Tang. Course
11	Diff. of Lat. and Departure	Course Distance	Sine Course	Departure	Rad.	Distance
12	Diff. of Lat. and Departure	Course Distance	Radius	Diff. Lat.	Secant Course	Distance

CASE I.

Course and distance sailed given, to find the difference of latitude and departure from the meridian.

A ship from the latitude of $49^{\circ} 57' N.$ sails S. W. by W. 488 miles; required the latitude she is in, and her departure from the meridian sailed from?

BY PROJECTION.



Draw the line CA to represent the meridian of the place C, from whence the ship sailed. With the chord of 60° in your compasses, and one foot in C as a centre, describe the compass N. W. S. E. Take 5 points in your compasses from the line of rhumbs on the plane scale, and set it off on the arch from S. towards W. for the course; through this point and C draw the line CB, which make equal to the distance 488; draw BA parallel to the E. and W. points W. E. to cut the meridian in A. Then will CA be the difference of latitude 271.1, and AB the departure 405.8.

BY LOGARITHMS.

By making the distance radius.

To find the departure.		To find the difference of latitude.	
As radius 8 points	10.00000	As radius 8 points	10.00000
Is to the distance 488	2.68842	Is to the distance 488	2.68842
So is the sine course 5 points	9.91985	So is co-sine course 5 points	9.74474
To the departure 405.8	2.60827	To the difference of lat. 271.1	2.43316

Now as the ship is in north latitude sailing southerly; from the latitude left $49^{\circ} 57' N.$ Take the difference of latitude $271.1 = 4^{\circ} 31' 8''$.

Gives the latitude in $45^{\circ} 26' N.$

And the departure from the meridian is 405.8 miles.

BY GUNTER.

Extend from radius or 8 points* to 5 points on the line marked SR: that extent will reach from the distance 488 to the departure 405.8 on the line of numbers.

Edly. Extend from radius or 8 points to 3 points, the complement of the course, on the line SR; that extent will reach from the distance 488 to the difference of latitude 271 on the line of numbers.

Thus may all the operations be performed in the several cases of Navigation.

By this case are calculated the tables of latitude and departure (TABLES I. and II.) for every degree, point, and quarter point of the mariner's compass, to the distance of 300 miles. By the inspection of these Tables, a day's work may be calculated in a much more expeditious manner than by logarithms or by Gunter's Scale. In consequence of this, the method by inspection is generally used at sea in preference to every other method.

BY INSPECTION.

Find the given course at the top or bottom of the tables, either among the points or degrees, and in that page, against the distance taken in its column, will stand the difference of latitude and departure in their columns.†

It must be observed, that in using these tables, the names Dist. Lat. Dep. must be found at the top if the course is found there, but if the course is found at the bottom, those names must be found at the bottom.

Thus the course S. W. by W. or 5 points, is found at the bottom of the table of difference of latitude and departure for points; and as the distance 488 is too great to be found in the tables, divide it by 2 (or any other convenient number) and that gives 244, which look for in the distance column, and against it stand 135.5 for the difference of latitude, and 202.9 for the departure, which being doubled (because divided by 2) give 271 for the difference of latitude, and 405.8 for the departure, the same as before.

CASE II.

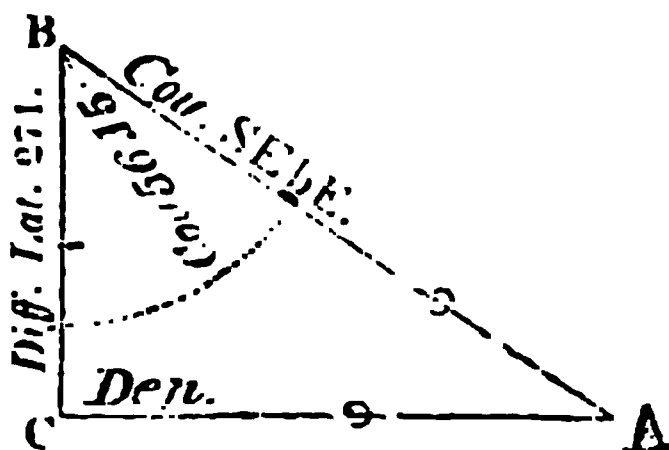
Course and difference of latitude given, to find the distance run, and departure from the meridian.

If a ship runs S. E. by E. from $1^{\circ} 45'$ north latitude, and then by observation is in $2^{\circ} 46'$ south latitude, what is her distance and departure?

In this case, as the ship has crossed the equator, the sum of the two latitudes $1^{\circ} 45'$ and $2^{\circ} 46'$ is the difference of latitude $4^{\circ} 31' = 271$ miles.

BY PROJECTION.

Draw $BC = 271$, and BA making an angle with BC equal to the course 5 points, or $56^{\circ} 15'$; draw CA perpendicular to BC to cut BA in A, and it is done: for CA will be the departure = 406, and AB the distance = 488.



BY LOGARITHMS.

By making diff. of lat. BC radius.

To find the departure.

As radius 4 points

Is to diff. of lat. 271

So is tang. course 5 pts.

To the departure 405.6

By making the Dep. AB radius.†

To find the distance.

As co-sine course 5 points

Is to the diff. of lat. 271

So is radius

To the distance 487.8

9.74474

2.43297

10.00000

2.68823

* When the course is given in points, make use of the lines marked sine rhumbs, and tangent rhumbs, on the upper side of the scale; when in degrees, make use of the lines marked sine and tangent.

† When the distance is too great to be found in the tables, you must divide it by 2, 3, 4, or any convenient number, the numbers corresponding to the quotient being multiplied by the divisor will give the sought numbers.

By making BC radius you would have Rad. : Diff. Lat. : Secant Course : Distance but you would not do for a common scale on which there is no line of secants. The same thing is proved in the following cases.

PLANE SAILING.

55

Hence the ship's distance run is 487.8 miles, and her departure from the meridian is 405.6 easterly.

BY GUNTER.

Extend from radius or 4 points to the course 5 points on the line marked TR, that extent will reach from the difference of latitude 271 to the departure 405.6 on the line of numbers.

2dly. Extend from the complement of the course 3 points to the radius 8 points on the line SR, that extent will reach from the difference of latitude 271 to the distance 488 on the line of numbers.

BY INSPECTION.

Find the course among the points or degrees, and the difference of latitude in its column, against which will stand the distance and departure in their columns.

Now, as the difference of latitude 271 is too great to be found in the tables, I divide it by 2, and that gives 135.5 which I find over S. E. by E. or 5 points in the latitude column; against that stand 244, for the distance, and 202.9 for the departure, which multiplied by 2 give the distance 488, and the departure 405.8.

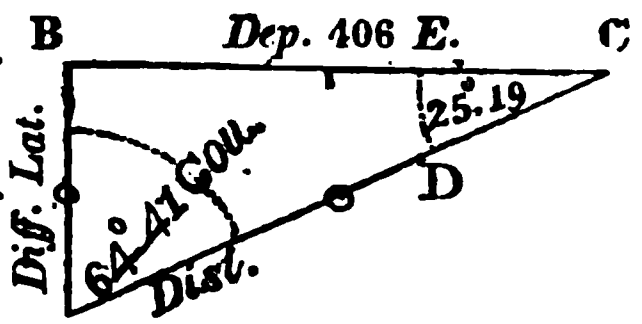
CASE III.

Course and departure from the meridian given, to find the distance and difference of latitude.

If a ship sails N. E. by E. $\frac{1}{4}$ E. from a port in $3^{\circ} 15'$ south latitude, until she depart from her first meridian 406 miles, I demand the distance sailed, and the latitude she is in?

BY PROJECTION.

Draw the meridian AB, upon which erect the perpendicular BC, and set off thereon the departure 406 easterly from B to C; with the chord of 60° , on C as a centre, describe an arch, and set off thereon the complement of the course DE; through D and C draw the line CDA, cutting the meridian in the point A; then AC measured on the same scale before used, gives the distance 440. and AB 192, the difference of latitude.



BY LOGARITHMS.

By making the departure BC radius.	By making the distance AC radius.
As radius 4 points	As sine course 5½ pts.
Is to the departure 406	Is to the departure 406
So is co-tang. course 5½ pts.	So is radius
10.00000	9.95616
2.60853	2.60853
9.67483	10.00000
2.28336	2.65237
To the diff. of lat. 192	To the distance 449,1
From the latitude left	3° 15' S.
Subtract the difference of latitude 192 miles, or	3 12 N.
The remainder being 3, shows the ship is in the latitude of	0 3 S.

BY GUNTER.

Extend from radius or 4 points to the co-course $2\frac{1}{2}$ points on the line marked TR; that extent will reach from the departure 408 to the difference of latitude 192 on the line of numbers.

2dly. Extend from the course $5\frac{1}{2}$ points to radius on the sines, that extent will reach from the departure 406 to the distance 449 miles on the line of numbers.

BY INSPECTION.

Find the course either among the points or degrees, and the departure in its column, against which will stand the distance and difference of latitude in their respective columns.

Thus with the course 5½ points, and half the departure 203* I find 224.5 for the distance, and 96.0 for the difference of latitude, which, being doubled, give the distance 449, and the difference of latitude 192.0, as before.

CASE IV.

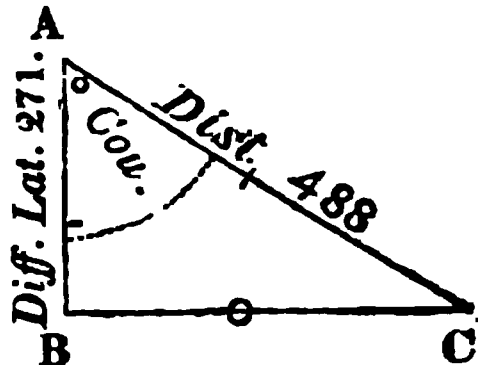
Distance and difference of latitude given, to find the course and departure.

Suppose a ship sails 488 miles, between the south and the east, from a port in $2^{\circ} 52'$ south latitude, and then by observation is in $7^{\circ} 23'$ south latitude; what course has she steered, and what departure has she made?

From the latitude by observation $7^{\circ} 23'$ take $2^{\circ} 52'$ the latitude left, the remainder $4^{\circ} 31' = 271$ miles, is the difference of latitude.

BY PROJECTION.

Draw the meridian $AB = 271$; upon which erect the perpendicular BC ; take 488 in your compasses, and with one foot on A , as a centre, describe an arch cutting BC in C ; join A and C ; then will BC be the departure 406, and the angle BAC the course $= 56^{\circ} 16'$ or five points nearly.



BY LOGARITHMS.

To find the course.		To find the departure.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the diff. of lat. 271	2.43297	So is sine course $56^{\circ} 16'$	9.91993
<hr/>		<hr/>	
To co-sine course $56^{\circ} 16'$	9.74455	To the departure 405.8	2.60835
Hence the course is S. E. by E. and the departure 405.8.			

BY GUNTER.

The extent from the distance 488, to the difference of latitude 271 on the line of numbers, will reach from radius, or 90° to $33^{\circ} 44'$, the co-course on the line of sines.

And the extent from radius, to $56^{\circ} 16'$ on the line of sines, will reach from the distance 488 to the departure 405.8 on the line of numbers.

BY INSPECTION.

Seek in the tables till against the distance taken in its column is found the given difference of latitude in one of the following columns, adjoining to it will stand the departure; which, if less than the difference of latitude, the course is to be found at the top;† but if greater, the course is to be found at the bottom,

Thus half the distance 244, and half the difference of latitude 135.5, are found to correspond to a course of 5 points or S. E. b. E. and to the departure 202.9, which being doubled, gives 405.8, as before.

CASE V.

Distance and departure given, to find the course and difference of latitude.

Suppose a ship sails 488 miles between the north and west, from the latitude of $32^{\circ} 25'$ north, until her departure is 405 miles, what course has she steered, and what latitude is she in?

* The nearest numbers in the table are 202.5 and 203.4, and as the number 203 is nearly a mean of these two values, I take the mean 224.5 of the corresponding distances 224, 225, and the mean 96 of the corresponding departures 95.8 and 96.2; these doubled give the true distance 449, and departure 192.

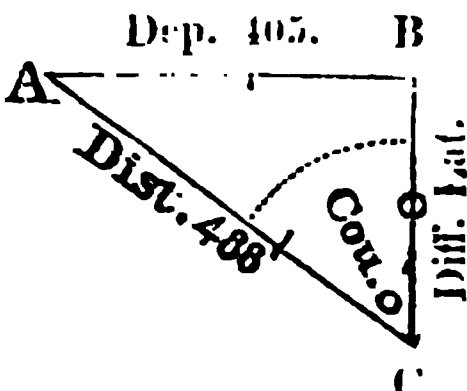
† It may also be known whether the course be marked at the top or bottom of the table, by observing whether the difference of latitude and departure correspond with the marks at the top or bottom. Thus the half distance 244, and half difference of latitude 135.5 correspond to the course 5 points, because the column in which 135.5 is found, is marked latitude at the bottom; the same may be observed in the following cases.

PLANE SAILING.

57

BY PROJECTION.

Draw the line AB equal to the departure 405. and perpendicular thereto the line BC to represent the meridian, then take the distance 488 in your compasses, and fixing one foot in A as a centre, describe an arch cutting BC in C. join AC and it is done: for the angle ACB will be the course, and BC the difference of latitude.



BY LOGARITHMS.

To find the course.		To find the difference of latitude.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the departure 405	2.60746	So is co-sine course $56^{\circ} 6'$	9.74644
<hr/>		<hr/>	
To the sine of course $56^{\circ} 6'$	9.91904	To the diff. of latitude 272.2	2.43486

Hence the course is N. $56^{\circ} 6'$ W. or N. W. by W. nearly.

To the latitude sailed from $32^{\circ} 25'$ add the difference of latitude 272. or $4^{\circ} 32'$, the sum $36^{\circ} 57'$ is the latitude the ship is in.

BY GUNTER.

Extend from the distance 488 to the departure 405 on the line of numbers, that extent will reach from radius to the course $56^{\circ} 6'$ on the line of sines.

2dly. Extend from radius to the complement of the course $33^{\circ} 54'$ on the line of sines, that extent will reach from the distance 488 to the difference of latitude 272 on the line of numbers.

BY INSPECTION.

Seek in the tables till against the distance, taken in its column, is found the given departure in one of the following columns; adjoining to it will stand the difference of latitude: which, if greater than the departure, the course is to be found at the top; but if less, the course is to be found at the bottom.

Thus half the distance 244, and half the departure 202.5, agree nearly to a course of 5 points or N. W. by W. and a difference of latitude 135.5, which being doubled, is 271, the difference of latitude, nearly as before.

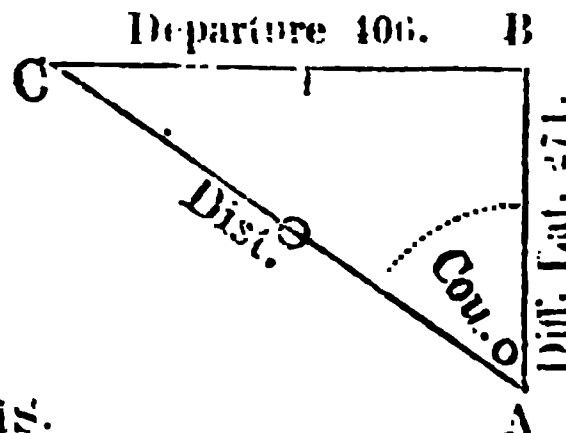
CASE VI.

Difference of Latitude and Departure given to find the Course and Distance.

A ship sails between the north and west till her difference of latitude is 271 miles, and her departure is 406 miles; I demand her course and distance!

BY PROJECTION.

Draw AB=271, and perpendicular to it BC=406: join C and A; then will the angle CAB be the course= $56^{\circ} 17'$, and AC the distance=488 miles.



BY LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of latitude 271	2.43297	As radius	10.00000
Is to radius	10.00000	Is to the diff. of latitude 271	2.43297
So is the departure 406	2.60853	So is sec. of course $56^{\circ} 17'$	10.25564
<hr/>		<hr/>	
To tang. of course $56^{\circ} 17'$	10.17556	To the distance 488.2	2.68861

Hence her course is N. $56^{\circ} 17'$ W. or N. W. by W. and the distance sailed is 488.2 miles.

BY GUNTER.

Extend from the difference of latitude 271 to the departure 406 on the line of numbers, that extent will reach from radius to $56^{\circ} 17'$ the course on the line of tangents.

2dly. For the distance we must consider it as radius (unless there is a line of secants on the scale) and extend from the course $56^{\circ} 17'$ to the radius or 90° on the line of sines, that extent will reach from the departure 406, to the distance 488 on the line of numbers.

BY INSPECTION.

Seek in the tables till the given difference of latitude and departure are found together in their respective columns, then against them will be the distance in its column, and the course will be found at the top of that table if the departure be less than the difference of latitude, otherwise at the bottom.

Thus with half the difference of latitude 135.5, and half the departure 208, enter the tables, and these numbers will be found to correspond nearly to 5 points or N. W. by W. course, and a distance equal to 244 miles, which being doubled gives the sought distance, 488.

Questions to exercise the learner in the foregoing Rules.

Question I. A ship in $2^{\circ} 10'$ south latitude, sails N. by E. 89 leagues; what latitude is she in, and what is her departure?

Answer. Latitude in $2^{\circ} 12'$ N. and departure 17,36 leagues.

Question II. A ship sails S. S. W. from a port in $41^{\circ} 30'$ north latitude, and then by observation is in $36^{\circ} 57'$ north latitude; I demand the distance run and departure?

Answer. Distance run 98,5 leagues, departure 37,7 leagues.

Question III. A ship sails S. S. W. $\frac{1}{2}$ W. from a port in $2^{\circ} 30'$ south latitude, until her departure be 59 leagues; I demand her distance run and latitude in?

Answer. Distance run 125,2 leagues, latitude in $8^{\circ} 1'$ south.

Question IV. If a ship sail 360 miles south westward from $21^{\circ} 59'$ south latitude, until by observation she be in $24^{\circ} 49'$ south latitude, what is her course and departure?

Answer. The course is S. W. by W. half W. or S. $61^{\circ} 49'$ W. and her departure from the meridian is 317,3 miles.

Question V. Suppose a ship sails 354 miles north eastward from $2^{\circ} 9'$ south latitude, until her departure be 150 miles, what is her course and latitude in?

Answer. Her course is N. $25^{\circ} 4'$ E. or N. N. E. $\frac{1}{2}$ E. nearly, and she is in latitude $3^{\circ} 12'$ N.

Question VI. Sailing between the north and the west, from a port in $1^{\circ} 59'$ south latitude, and then arriving at another port in $4^{\circ} 8'$ north latitude, which is 209 miles to the westward of the first port—I demand the course and distance from the first port to the second?

Answer. The course is N. $29^{\circ} 40'$ W. or N. N. W. $\frac{1}{2}$ W. nearly, and the distance of the ports is 422,4 miles, or 140,8 leagues.

Question VII. Four days ago we were in lat. $3^{\circ} 25'$ S. and have since that time sailed in a direct course N. W. by N. at the rate of 3 miles an hour; required our present latitude and departure?

Answer. Latitude in $7^{\circ} 14'$ N. Departure 426,7 miles.

Question VIII. A ship in the latitude of $3^{\circ} 52'$ S. is bound to a port bearing N. W. by W. $\frac{1}{2}$ W. in the latitude of $4^{\circ} 30'$ N. how far does that port lie to the westward, and what is the ship's distance from it?

Answer. The port lies 939,2 miles to the westward, and the direct distance 1065 miles.

Question IX. A ship from the latitude of $48^{\circ} 17'$ N. sails S. W. by S. until she has depressed the north pole 2 degrees; what direct distance has she sailed, and how many miles has she got to the westward?

Answer. Distance run 144,3 miles, and has got to the westward 80,2 miles.

TRAVERSE SAILING.



A TRAVERSE is an irregular track which a ship makes by sailing on several different courses; these are reduced to a single course by means of two or more cases of Plane Sailing, either by geometrical construction, or by arithmetical calculation.*

The geometrical construction is performed as follows: Describe a circle with the chord of 60° , to represent the compass, and lay off on its circumference the various courses sailed. From the centre, upon the first course set off the first distance, and mark its extremity: through this extremity, and parallel to the second course, draw the second distance of its proper length: through the extremity of the second distance, and parallel to the third course, draw the third distance of its proper length; and thus proceed till all the distances are drawn. A line, drawn from the extremity of the last distance to the centre of the circle, will represent the distance made good; a line, drawn from the same point, perpendicular to the meridian, will represent the departure; and the part of the meridian intercepted between this and the centre, will represent the difference of latitude.

The arithmetical calculation to work a traverse is as follows; Make a traverse table consisting of six columns; title them, Course, Dist. N. S. E. W. begin at the left side, and write the given courses and distances in their respective columns. Find the difference of latitude and departure for each of these courses, by Gunter's Scale, or by Tables I. or II. (as in Case I. Plane Sailing) and write them in their proper columns: that is, when the course is southerly, the difference of latitude must be set in the column S. when northerly in the column N. The departure, when westerly, in the column W. and when easterly in the column E. Add up the columns of northing, southing, easting, and westing; take the difference between the northing and southing, and also between the easting and westing; the former difference will be the difference of latitude, which will be of the same name as the greater; and the latter will be the departure, which will be also of the same name as the greater. With this difference of latitude and departure, the course and distance made good are to be found as in Case VI. Plane Sailing.

EXAMPLE I.

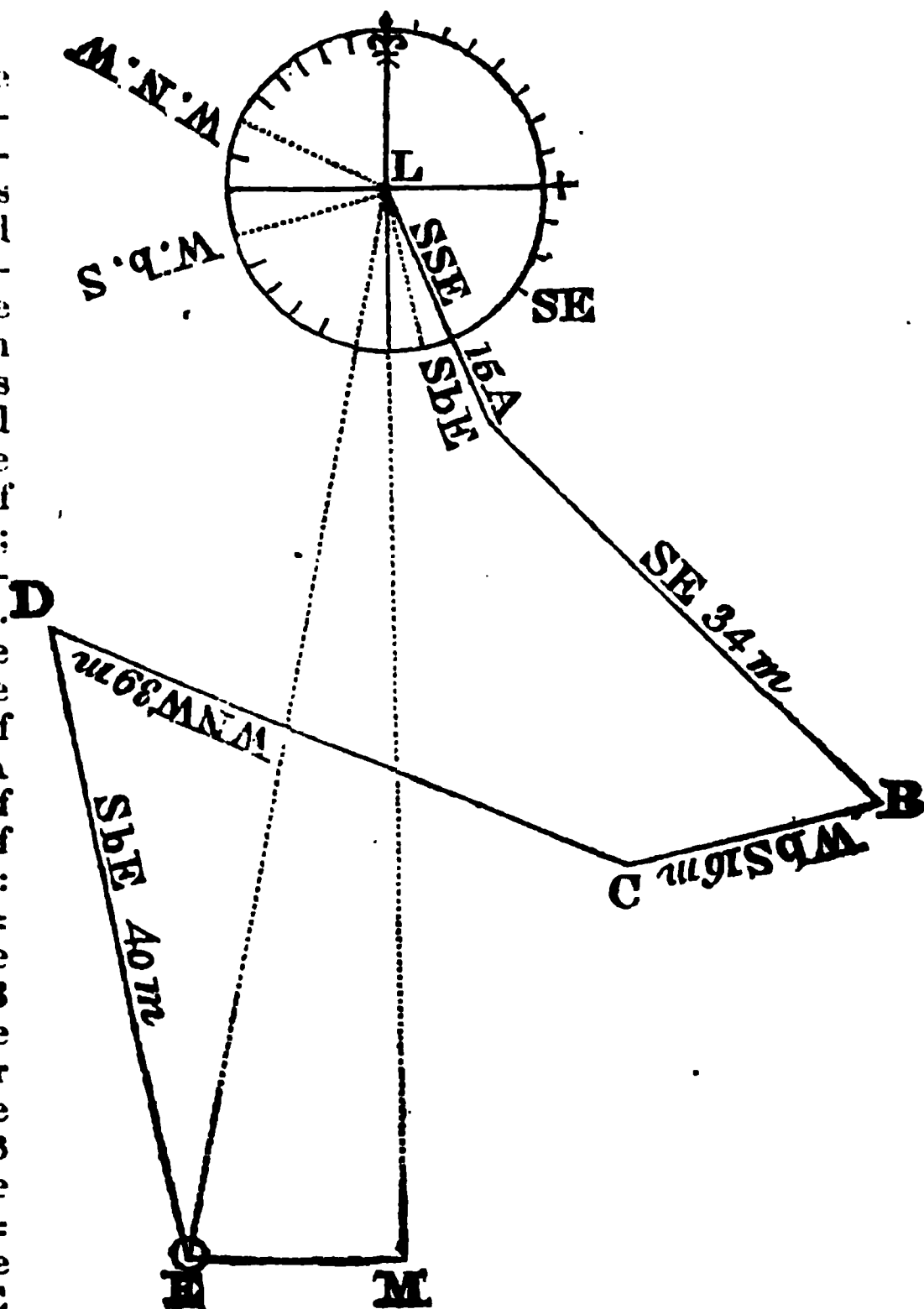
Suppose a ship takes her departure from Block Island, in the latitude of $41^\circ 10'$ N. the middle of it bearing N. N. W. distance by estimation 5 leagues. and sails S. E. 34. W. by S. 16, W. N. W. 39, and S. by E. 40 miles; required the latitude she is in, and her bearing and distance from Block Island!

* This method of reducing compound courses to a single one is perfectly accurate in sailing on a plane, and is nearly so in sailing a short distance on the spherical surface of the earth; and though in this case it is liable to a small error in high latitudes, yet in general the rule is sufficiently accurate for reducing the several courses and distances sailed in one day to a single course and distance.

TRAVERSE SAILING.

BY PROJECTION.

Let L represent the middle of Block-Island; draw the meridian LM, and on L as a centre, with a chord of 60° , describe a circle to represent the compass, on which mark the various courses sailed, and the bearing of the land at the time of taking the departure; opposite to this bearing draw the S. S. E. line LA, which make equal to 15 miles, the estimated distance of the land; then will A represent the place of the ship at the time of taking the departure: through A draw AB=34 miles parallel to the S. E. line; then will B be the place of the ship after sailing her first course; in like manner draw BC=16 miles parallel to the W. by S. line: CD=39 miles parallel to the W. N. W. line, and DE=40 miles parallel to the S. by E. line; then will E represent the place of the ship after sailing her several courses. Join EL, and draw EM perpendicular to LM; then will LE be the distance of Block-Island 66.8 miles, and the angle ELM= $12^\circ 16'$ will be the course made good, LM the difference of latitude, and EM the departure.



TO FIND THE SAME BY LOGARITHMS.

For the first course S. S. E. 15 miles.

To find the difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to distance 15	1.17609	Is to distance 15	1.17609
So is co-sine course 2 points	9.96562	So is sine course 2 points	9.58284
To Diff. lat. 13.9		To departure 5.7	
	1.14171		0.75893

Second course S. E. 34 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 45°	9.84949	Is to sine course 45°	9.84949
So is distance 34	1.53148	So is distance 34	1.53148
To diff. latitude 24		To departure 24	
	1.38097		1.38097

Third course W. by S. 16 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course $78^\circ 45'$	9.29024	Is to sine-course $78^\circ 45'$	9.99157
So is distance 16	1.20412	So is distance 16	1.20412
To diff. latitude 3.1		To departure 15.7	
	0.49436		1.19569

TRAVERSE SAILING.

61

Fourth course W. N. W. 39 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 67° 30'	9.78294	Is to sine course 67° 30'	9.96562
So is distance 39	1.59106	So is distance 39	1.59106
<hr/>		<hr/>	
To diff. lat. 14.9	1.17390	To departure 36	1.55668

Fifth course S. by E. 40 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 11° 15'	9.99157	Is to sine course 11° 15'	9.29024
So is distance 40	1.60206	So is distance 40	1.60206
<hr/>		<hr/>	
To diff. lat. 39.2	1.59363	To departure 7.8	0.89230

Though this method of finding the difference of latitude and departure by logarithms is accurate, yet the calculations may be more easily made by the tables of difference of latitude and departure, as in Case I. Plane Sailing.

TRAVERSE TABLE.

Place all these courses, distances, &c. in the traverse table, then add up all the westings, eastings, northings, and southings, separately, and set down their respective sums at the bottom of each column; and as the westing is greater than the easting subtract the easting therefrom; the difference 14.2 shews that the ship's departure is so much west of her first meridian.

Course.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. S. E.	15		13.9	5.7	
S. E.	34		24.0	24.0	
W. by S.	16		3.1		15.7
W. N. W.	39	14.9			36.0
S. by E.	40		39.2	7.8	
From sum	—	—	80.2	37.5	51.7
Take	—	—	14.9	—	37.5
Remains	—	—	65.3		14.2

Again, the southing being greater than the northing, subtract the northing from it, and the remainder 65.3 shews how far the ship is to the southward of her first place.

To find the direct course or bearing of Block Island from the ship.

As the diff. lat. 65.3	1.81491
Is to radius 45°	10.00000
So is the departure 14.2	1.15229
<hr/>	
To tang. course 12° 16'	9.33738

To find the distance of the Island.

As sine of course 12° 16'	9.32729
Is to the departure 14.2	1.15229
So is radius 90°	10.00000
<hr/>	
To the distance 66.8	1.82501

Which, because the difference of latitude is southerly, and the departure westerly, is E. 12° 16' W. Whence Block Island lies from the ship N. 12° 16' E. or N. by E. 1° 1' E.

BY INSPECTION.

Find the course and distance by Case VI. of Plane Sailing.

EXAMPLE II.

A ship from Mount-Desert Rock, in the latitude of 43° 52' N. sails for Cape Cod in the latitude of 42° 5' N. its departure from the meridian of Mount-Desert Rock being supposed to be 84 miles west; but by reason of contrary winds, she is obliged to sail on the following courses, viz. South 10 miles, W. S. W. 25 miles, S. W. 30 miles, and W. 20 miles. Required the bearing and distance of the two places, the course and distance sailed by the ship, and the bearing and distance of her intended port?

BY PROJECTION.

Lat. Mount-Desert Rock $43^{\circ} 52' N.$
 Lat. of Cape Cod $42^{\circ} 5' N.$

Diff. of lat. $1^{\circ} 47' = 107$ miles.

Let C represent Mount-Desert Rock, draw the meridian CF, which make equal to 107 miles the difference of latitude between the two places;

and perpendicular thereto the line FE equal to the departure

84 miles,

then is E

the place of

Cape Cod.

With the

chord of

60° sweep

about the

centre C, a

circle E. S.

W. to re-

present the

compass, &

upon it note

the various

coursessail-

ed. The

first course

being South

the distance

10 miles is

set off from

C towards F upon the meridian, and this point represents the place of the ship after sailing her first course; continue setting off the various courses and distances as in the last example, viz. W. S. W. 25 miles, S. W. 30 miles, and West 20 miles to the point A; then will A represent the place of the ship after sailing these courses. Join CE, AC, AE; draw AB perpendicular to the meridian CF, and AD parallel thereto: then will AC=76,2 miles be the distance made good, AE=69,1 miles the distance of Cape Cod from the ship; CE the distance of the two places=136 miles; $ACB=57^{\circ} 36'$, the course made good; $EAD=16^{\circ} 34'$ the course to Cape Cod, and ECF the course from Mount-Desert Rock to Cape Cod= $38^{\circ} 8'$, &c.

BY LOGARITHMS.

To find the bearing and distance of the two places by Case VI. Plane Sailing.

To find the bearing.

As diff. of lat. 107

Is to radius 45°

So is departure 84

2.02938

10.00000

1.92428

To tang. course $39^{\circ} 8'$

9.99490

To find the distance.

As radius 90°

Is to diff. of lat. 107

So is sec. course $39^{\circ} 8'$

10.00000

2.02938

10.10426

To the distance 136

2.13364

Whence the course from Mount-Desert Rock to Cape Cod is S. $39^{\circ} 8'$ W. distance 136 miles. The same may be found by the scale or by inspection.

TRAVERSE TABLE.

The difference of latitude and departure for the several courses being calculated, by Case I. Plane Sailing, and arranged in the traverse table, it appears that the difference of latitude made good by the ship is 40,8 miles; and the departure 64,3 miles; then by Case VI. Plane Sailing, these numbers are found to correspond to a course of S. $57^{\circ} 36'$, W. and distance 76,2 miles.

Courses.	Dist.	Diff. Lat.		Departure	
		N.	S.	E.	W.
South.	10		10.0		
W. S. W.	25		9.6		23.1
S. W.	30		21.2		21.2
W.	20				20.0
Diff. Lat.		40.8		Dep. 64.3	

Subtract the difference of latitude made good by the ship 40,8 miles, from the whole difference of latitude 107 miles, and there remain 66,2 miles, which is the difference of latitude between the ship and Cape Cod. In the same manner by subtracting the ship's departure, 64,3 miles, from the whole departure, 84 miles, there remain 19,7 miles for the departure between the ship and Cape Cod. With this difference of latitude, 66,2, and departure, 19,7, the bearing of Cape Cod is found, by Case VI. Plane Sailing, S. 16° 34' W. and its distance 69,1 miles.

All the preceding calculations may be made by logarithms, by the scale, or by inspection. But we shall leave them to exercise the learner; and for the same purpose shall add the following example.

EXAMPLE III.

A ship in the latitude of $37^{\circ} 10'$ N. is bound to a port in the latitude of $53^{\circ} 4'$ N. which lies 180 miles west of the meridian of the ship; but by reason of contrary winds she sails the following courses, viz. S. W. by W. 27 miles—W. S. W. $\frac{1}{4}$ W. 30 miles—W. by S. 25 miles—W. by N. 18 miles—S. S. E. 32 miles—S. S. E. $\frac{1}{4}$ E. 27 miles—S. by E. 25 miles—S. 31 miles, and S. S. E. 39 miles. Required the latitude the ship is in, and her departure from the meridian, with the course and distance to her intended port!

TRAVERSE TABLE.

The difference of latitude and departure made on each course, are given in the adjoined traverse table; hence it appears that the difference of latitude made good is 169.4 miles, the departure 47.4 miles, and by Case VI. Plane Sailing, the course S. $15^{\circ} 38'$ W. and distance 175.9 miles; and the course to the intended port S. $58^{\circ} 42'$ W. distance 155.2 miles; the latitude being in $54^{\circ} 21'$ N.

Courses.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. W. by W.	27		15.0		22.4
W. S. W. $\frac{1}{4}$ W.	30		8.7		23.7
W. by S.	25		4.9		24.5
W. by N.	18	3.5			17.7
S. S. E. *	32		29.6	12.2	
S. S. E. $\frac{1}{4}$ E.	27		23.2	13.9	
S. by E.	25		24.5	4.9	
South	31		31.0		
S. S. E. *	39		36.0	14.9	
		3.5	172.9	45.9	93.3
			3.5		45.9
		Diff. Lat. 169.4		Dep. 47.4	

PARALLEL SAILING.

IN Plane Sailing the earth is considered as an extended plane, but this supposition is very erroneous, because the earth is nearly of a spherical figure, in which the meridians all meet at the poles, consequently the distance of any two meridians measured on a parallel of latitude (which distance is called the meridian distance) decreases in proceeding from the equator to the poles. To illustrate this, let PB represent the semi-axis of the earth, B the centre, P the pole, PCA a quadrant of the meridian, AB the radius of the equator, and CD (parallel thereto) the radius of a parallel of latitude. Then it is evident that CD will be the co-sine of AC or the co-sine of the latitude of the point C, to the radius AB: now if the quadrantal arch PCA be supposed to revolve round the axis PB, the point A will describe the circumference of the equator, and C the circumference of a parallel of latitude; and the former circumference will be to the latter as AB to CD (as may easily be deduced



* Instead of putting the course S. S. E. 32 miles, and S. S. E. 39 miles, you might make one entry each, calling it S. S. E. 71 miles.

from Art. LV. Geometry;) that is, as radius to the co-sine of the latitude or the point C: hence it follows, that the length of any arch of the equator intercepted between two meridians, is to the length of a corresponding arch of any parallel intercepted between the same meridians, as radius is to the co-sine of the latitude of that parallel. Hence we obtain the following theorems.

THEOREM I.

The circumference of the equator is to the circumference of any other parallel of latitude, as radius is to the co-sine of that latitude.

THEOREM II.

As the length of a degree of the equator is to the meridian distance corresponding to a degree on any other parallel of latitude, so is radius to the co-sine of that parallel of latitude.

THEOREM III.

As radius is to the co-sine of any latitude, so are the miles of difference of longitude between two meridians (or their distance in miles upon the equator) to the distance of these two meridians on that parallel of latitude in miles.

THEOREM IV.

As the co-sine of any latitude is to radius, so is the length of any arch on that parallel of latitude (intercepted between two meridians) in miles to the length of a similar arch on the equator, or miles of difference of longitude.

THEOREM V.

As the co-sine of any latitude is to the co-sine of any other latitude, so is the length of any arch on the first parallel of latitude in miles, to the length of the same arch on the other in miles.

By means of Theorem II. the following Table was calculated, which shows the meridian distance corresponding to a degree of longitude in every latitude: and may be made to answer for any degree or minute by taking proportional parts.

The following Table shews for every degree of latitude how many miles distant the two meridians are, whose difference of longitude is one degree.

D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.
1	59. 99	19	56. 73	37	47. 92	55	34. 41	73	17. 54
2	59. 96	20	56. 38	38	47. 28	56	33. 55	74	16. 54
3	59. 92	21	56. 01	39	46. 63	57	32. 68	75	15. 53
4	59. 85	22	55. 63	40	45. 96	58	31. 80	76	14. 52
5	59. 77	23	55. 23	41	45. 28	59	30. 90	77	13. 50
6	59. 67	24	54. 81	42	44. 59	60	30. 00	78	12. 47
7	59. 55	25	54. 38	43	43. 88	61	29. 09	79	11. 45
8	59. 42	26	53. 93	44	43. 16	62	28. 17	80	10. 42
9	59. 28	27	53. 46	45	42. 43	63	27. 24	81	9. 39
10	59. 09	28	52. 98	46	41. 68	64	26. 30	82	8. 35
11	58. 90	29	52. 48	47	40. 92	65	25. 36	83	7. 31
12	58. 69	30	51. 96	48	40. 15	66	24. 40	84	6. 27
13	58. 46	31	51. 43	49	39. 36	67	23. 44	85	5. 23
14	58. 22	32	50. 88	50	38. 57	68	22. 48	86	4. 19
15	57. 96	33	50. 32	51	37. 76	69	21. 50	87	3. 14
16	57. 68	34	49. 74	52	36. 94	70	20. 52	88	2. 09
17	57. 38	35	49. 15	53	36. 11	71	19. 53	89	1. 05
18	57. 06	36	48. 54	54	35. 27	72	18. 54	90	0. 00

When a ship sails east or west on the surface of the earth supposed to be spherical, she describes a parallel of latitude, and this is called *Parallel Sailing*. In this case, the distance sailed (or departure) is equal to the distance between the meridians sailed from and arrived at in that parallel, and it is easy, by Theorem IV. (preceding) to find the difference of longitude from the distance, or the distance from the difference of longitude, as will appear plain by the following examples.

PARALLEL SAILING.

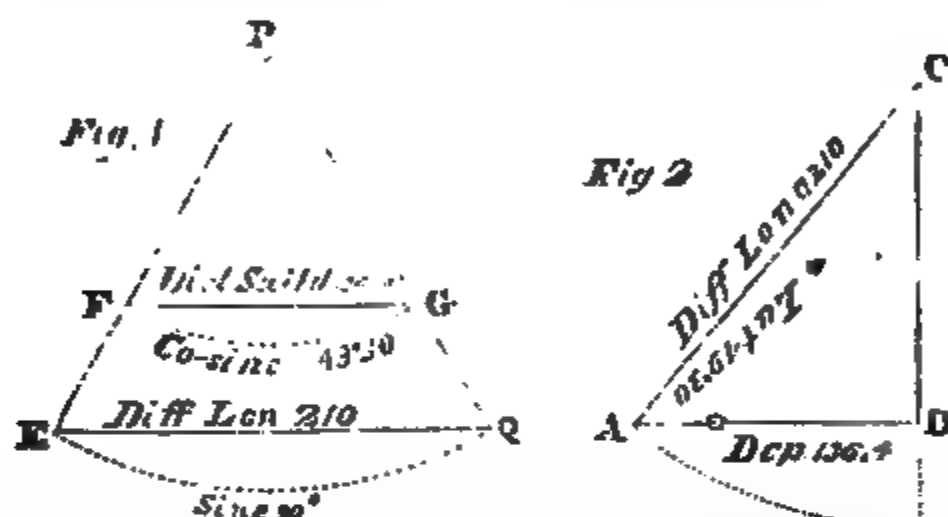
65

CASE I.

The difference of longitude between two places in the same parallel of latitude being given, to find the distance between them.

Suppose a ship in the latitude of $49^{\circ} 30'$ north or south, sails directly east or west until her difference of longitude be 210 , required the distance sailed?

BY PROJECTION.



Take the sine of 90° from the Plane Scale, and with one foot of the compasses on P (Fig. 1) as a centre, describe the arch EQ; with the difference of longitude 210 miles in the compasses, and one foot in E, as a centre, describe an arch cutting EQ in Q; join PE, PQ. Take the sine of the complement of the latitude $49^{\circ} 30'$ in your compasses, and with one foot in P, as a centre, describe the arch FG, cutting PE, PQ, in FG; then the length of the chord FG being measured on the scale of equal parts will be the departure 136.4 miles.

Or this projection may be made in the following manner. Draw AD (Fig. 2) of an indefinite length, make the angle DAC equal to the latitude $49^{\circ} 30'$, and AC equal to the difference of longitude 210 miles; draw CD perpendicular to AD; then will the line AD be the distance or departure required.

BY LOGARITHMS.

To find the departure or distance.

As radius 90-	10.00000
Is to the difference of longitude 210	2.32222
So is co-sine latitude $49^{\circ} 30'$	9.81254
To the distance or departure 136.4	2.13476

BY GUNTER.

The extent from radius to the complement of the latitude $40^{\circ} 30'$ on the line of sines, will reach from the difference of longitude 210 to the distance 136.4 on the line of numbers.

BY INSPECTION.

Find the latitude among the degrees in Table II. and in the distance column the difference of longitude, opposite to which in the column of latitude will be the distance required.

In the present example the latitude is $49^{\circ} 30'$, and as the table is only calculated to single degrees, I find the numbers in the tables of 49° and 50° , and take the mean of them; the former is 137.8 , the latter 135.0 , the mean of which is the sought distance or departure 136.4 .

CASE II.

The distance between two places on the same parallel of latitude given, to find their difference of longitude.

Suppose a ship in the latitude of $49^{\circ} 30'$ N. or S. and long. $36^{\circ} 40'$ W. sails directly west 136.4 miles; required the difference of longitude, and longitude in?

L

BY PROJECTION.

With the sine of the complement of the latitude $40^{\circ} 30'$ in your compasses, and one foot in P, as a centre, (Fig. 1st. of the preceding case) describe the arch FG, upon which set off the departure 136.4 miles upon the chord FG, and through the points F and G draw the lines PE and PQ—then with the sine of 90° in the compasses, and one foot on P as a centre, describe an arch to cut PE, PQ, in E and Q; then the chord EQ being measured upon the same scale of equal parts that the departure was, will be the difference of longitude 210 miles.

Or thus, draw the line AD (Fig. 2d.) which make equal to the given distance 136.4, at D erect DC perpendicular to DA, make the angle DAC equal to the latitude; then will AC be the sought difference of longitude 210 miles.

BY LOGARITHMS.

As co-sine of latitude $49^{\circ} 30'$	9.81254	Long. left	$36^{\circ} 40' W.$
Is to the distance 136.4	2.13481	Diff. long.	3 30 W.
So is radius	10.00000		
	<hr/>		
		Long. in	40 10 W.
To the diff. of long. 210	2.32227		

BY INSPECTION.

Look for the latitude among the degrees, as if it was a course, and the departure in the column of latitude; against which will stand the difference of longitude in the distance column.

Thus in the course 49° , I seek for 136.4 in the latitude column, and find it corresponds to the distance 208; and in the course 50° , I find it nearly corresponds to 212; half the sum of 208 and 212 is 210, which is the sought difference of longitude.

QUESTIONS TO EXERCISE THE LEARNER.

Question I. A ship in the latitude of $52^{\circ} N.$ sails due east till her difference of longitude is 304 miles; required the distance sailed!

Answer. 325.7 miles.

Question II. A ship from the latitude of $55^{\circ} 57' S.$ longitude $10^{\circ} 18' E.$ sails due west 236 miles—required her present longitude?

Answer. $3^{\circ} 40' E.$

Question III. If two ships in the latitude of $44^{\circ} 50' N.$ distant 216 miles, should sail directly south until they were in the latitude of $32^{\circ} 17' N.$ what distance are they from each other?

Answer. By Theorem V. 256 miles.

Question IV. A ship having run due east for three days, at the rate of 5 knots an hour, finds she has altered her longitude $3^{\circ} 16'$; what parallel of latitude did she sail in?

Answer. $43^{\circ} 23' N.$ or $S.$



MIDDLE LATITUDE SAILING.

IN sailing north or south (or on a meridian) the difference of longitude is nothing, and the difference of latitude is equal to the distance sailed; but in sailing east or west (or on a parallel of latitude) the difference of latitude is nothing, and the difference of longitude may be calculated by the foregoing Theorems of Parallel Sailing. In sailing on any other course, the ship changes both her latitude and longitude; in this case, the difference of latitude, departure, and difference of longitude may be calculated by a proper application of the principles of Plane Sailing to the sailing on a spherical surface; to do which, the surface of the globe may be supposed to be divided into an indefinite number of small surfaces, as square miles, furlongs, yards, &c. which on account of their smallness, in comparison with the whole surface of the earth, may be esteemed as plane surfaces, and the difference of latitude and departure (or meridian distance) made in sailing over each of these surfaces, may be calculated by the common rules of Plane Sailing, and by summing up all the differences of latitude and departures made on these different planes, we shall obtain the whole difference of latitude and departure nearly.* Now, by Case I. of Plane Sailing, the distance described on any one of these small surfaces is to the corresponding difference of latitude as radius is to the co-sine of the course, and as the course is

* The error arising from this supposition will be decreased by increasing the number of the planes, so that by increasing the number indefinitely, the error may be made less than any assignable quantity.

The same on all these surfaces, it follows that the sum of all the distances described thereon is to the sum of the corresponding differences of latitude as radius is to the co-sine of the course; that is, the whole distance sailed on the globe is to the corresponding difference of latitude as radius is to the co-sine of the course. In a similar manner it appears, that the distance described on the globe is to the sum of all the corresponding departures (or meridian distances) described on these different surfaces, as radius is to the sine of the course. So that the canons for calculating the whole difference of latitude and departure from the course and distance are the same, whether the earth be esteemed as an extended plane or a spherical surface, and the same is to be observed with respect to the other cases of Plane Sailing.

We shall, therefore, in all the calculations of sailing on the spherical surface of the earth, in which the course, distance, difference of latitude and departure occur, make use of the canons already taught in Plane Sailing, and shall construct the schemes exactly in the same manner. The only additional calculation in sailing on a spherical surface consists in determining the longitude from the departure: for in sailing on a plane, the departure and longitude are the same, but in sailing on a spherical surface, *the whole departure (as was observed above) is equal to the sum of all the meridian distances made in sailing over the indefinite number of small surfaces, into which we have supposed the spherical surface to be divided, and the whole difference of longitude corresponding is equal to the sum of all the differences of longitude, deduced from each of these small meridian distances by Theorem IV. of Parallel Sailing.** Several methods have been proposed for abridging the calculation of the difference of longitude from the departure, the most noted of which are those known by the names of *Middle Latitude Sailing* and *Mercator's Sailing*, the latter (which will be hereafter explained) is perfectly accurate,† the former is only an approximation, but it is very much used in calculating short runs and days works, but in calculating large distances across d's ant parallels it is liable to error. The principle on which the calculations of Middle Latitude Sailing is founded, is this:—Instead of calculating the difference of longitude corresponding to the departure made on each of the small surfaces, into which we have supposed the sphere to be divided, and adding them together, the whole departure (or sum of the meridian distances) is calculated, and the longitude deduced therefrom by the rules of Parallel Sailing, using for the latitude the arithmetical mean between the latitude sailed from and that arrived to. On this supposition, we have the two first of the following theorems for calculating the departure from the difference of longitude, or the difference of longitude from the departure, which are the same as Theo. III. and IV. of Parallel Sailing, except in writing departure for distance, and middle latitude for latitude: the other theorems are easily obtained by combining the two first with the common theorems of Plane Sailing: observing that the *Middle Latitude is half the sum of the two latitudes, if they are of the same name, or half their difference if of contrary names.*

THEOREM I.

As radius is to the co-sine of the middle latitude, so is the difference of longitude to the departure.

THEOREM II.

As the co-sine of the middle latitude is to the radius, so is the departure to the difference of longitude.

Now by case I. of Plane Sailing, the radius is to the sine of the course, as the distance sailed is to the departure, and, if we combine this analogy with Theorem II. we shall have,

* Using (in estimating the difference of longitude corresponding to each of these small meridian distances) the latitude corresponding to the middle point of the surface on which these small meridian distances are respectively made.

† This is true in theory, and would be so in practice, if the meridional difference of latitude in Table III. were given to a sufficient number of decimals, but being only given to the nearest mile or minute, the error arising from this cause, when the difference of latitude is small, is greater than the error in middle latitude sailing; in consequence of this, the method by middle latitude is almost exclusively used in the common operations on shipboard.

THEOREM III.

As the co-sine of the middle latitude is to the sine of the course, so is the distance sailed to the difference of longitude.

By Case II. of Plane Sailing, we have this analogy; as radius is tangent of the course, so is the difference of latitude to the departure combining this with Theorem II. we have

THEOREM IV.

As the co-sine of the middle latitude is to the tangent of the course, so the difference of latitude to the difference of longitude.

Whence we easily deduce the following.

THEOREM V.

As the difference of latitude is to the difference of longitude, so is the middle latitude to the tangent of the course.

By means of the preceding theorems we have formed the following which contains all the rules necessary for solving the various cases of Latitude Sailing.

MIDDLE LATITUDE SAILING.

Case.	Given.	Sought.	SOLUTION.
1	Both Latitude and Longitude.	Departure. Course. Distance.	Rad. : Diff. Long. :: Co-sine Mid. Lat. : Dep. { Diff. Lat. : Rad. :: Dep. : Tang. Course. { Diff. Lat. : Diff. Long. :: Cos. Mid. Lat. : Tang. Course. { Rad. : Diff. Lat. :: Secant Course : Distance. { Sine Course : Depart. :: Rad. : Distance.
2	Both Latitude and Departure.	Course. Distance. Diff. Long.	Diff. Lat. . Rad. :: Dep. : Tang. Course. Sine Course : Dep. :: Rad. : Distance. Co sine Mid. Lat. : Dep. :: Rad. : Diff. Long
3	One Latitude, Course and Distance.	Diff. Lat. Departure. Diff. Long.	Rad. : Dist. :: Co-sine Course : Diff. Lat. Hence the other Latitude and Middle Latitude are found. Rad. : Dist. :: Sine Course : Departure. { Co-Sine Mid. Lat. : Dep. :: Rad. : Diff. Long. { Co-Sine Mid. Lat. : Sine Course :: Dist. : Diff. Long.
4	Both Latitudes and Course.	Departure Distance. Diff. Long.	Rad. : Diff. Lat. :: Tang. Course : Departure. Co-sine Course : Diff. Lat. :: Rad. : Distance. { Co-sine Mid. Lat. : Dep. :: Rad. : Diff. Long. { Cos. Mid. Lat. : Tang. Course :: Diff. Lat. : Diff. Long.
5	Both Latitudes and Distance.	Course. Departure. Diff. Long	Dist. : Rad. :: Diff. Lat. : Co-sine Course. Rad. : Dist. :: Sine Course : Departure. Co-sine Mid. Lat. : Dep. :: Rad. : Diff. Long.
6	One Latitude, Course and Departure.	Diff. Lat. Distance. Diff. Long.	Rad. : Dep. :: Co-tang. Course : Diff. Lat. Hence the other Latitude and Middle Latitude are known. Sine Course : Departure :: Rad. : Distance. Co-sine Mid. Lat. : Dep. :: Rad. : Diff. Long.
7	One Latitude, Distance and Departure.	Course. Diff. Lat. Diff. Long.	Dist. : Rad. :: Dep. : Sine Course. Rad. : Dist. :: Co-sine Course : Diff. Lat. Hence we obtain latitude and middle latitude. Co-sine Mid. Lat. : Dep. :: Rad. : Diff. Long.

We shall now proceed to illustrate these rules, by working an example in every case.

CASE I.

The latitudes and longitudes of two places given, to find their bearing and distance.

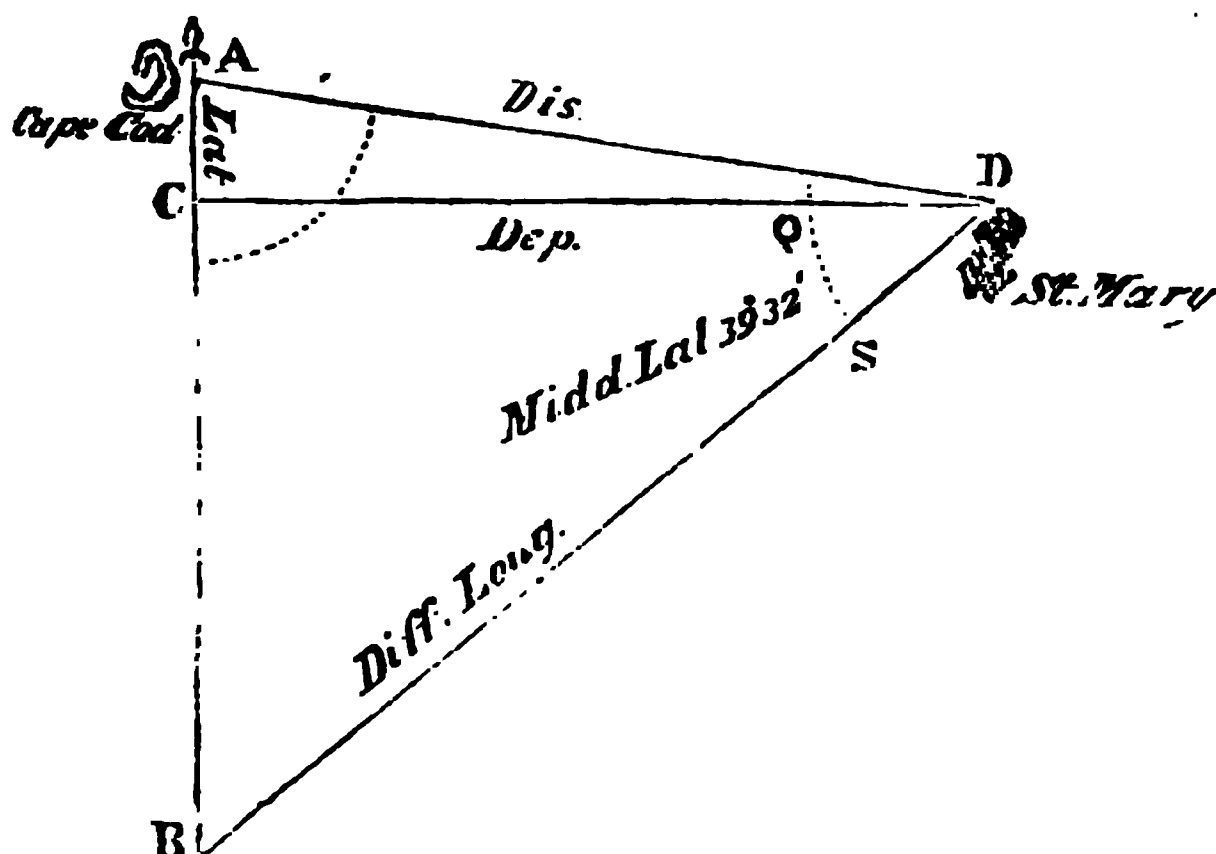
Required the bearing and distance between Cape Cod light-house, latitude of 42° 5' N. longitude 70° 4' W. and the island of St. Mary, (the Western Islands) in the latitude of 36° 59' N. and longitude 25° 1'

Cape Cod's lat.	42° 5' N.	42° 5'	Long. 70°
St. Mary's lat.	36 59 N.	36 59	Long. 25 1'
Diff. lat.	5 6	Sum 79 4	44 5
	60		60
In miles	306	Mid. lat. 39 32	Diff. long. 2694

MIDDLE LATITUDE SAILING.

69

BY PROJECTION.



Draw the east and west line DC, with the chord of 60° describe the arch QS about the centre D, to cut DC in Q: upon this arch, set off, from Q to S, the middle latitude $39^\circ 32'$; through D and S draw the line DB, which make equal to the difference of longitude 2694 miles; from B let fall upon DC the perpendicular BC, which continue towards A making AC equal to the difference of latitude 306 miles;* join AD, and it is done. For by this method of construction, on the principles before explained, A will be the situation of Cape Cod, D the situation of St. Mary; CD will be the departure, which being measured will be found to be 2078 miles; the distance will be represented by AD, which being measured will be found to be 2099 miles, and the course from Cape Cod to St. Mary, will be represented by the angle $CAD=81^\circ 37'$; therefore the course will be S. $81^\circ 37'$ E. or E. $\frac{1}{4}$ S. nearly.

NOTE. The course is put S. $81^\circ 37'$ E. because St. Mary being in a less northern latitude than Cape Cod, is to the southward of it; it is also to the eastward of Cape Cod, because it is in a less western longitude.

BY LOGARITHMS.

To find the departure (by Theorem I.)		To find the course.	
As radius 90°	10.00000	As diff. of lat. 306	2.48572
Is to diff. of long. 2694	3.43040	Is to radius 45°	10.00000
So is co-sine mid. lat. $39^\circ 32'$	9.88720	So is the departure 2078	3.31760
To the departure 2078	3.31760	To tang. of course $81^\circ 37'$	10.83188
To find the distance.		NOTE. The course may be found without the departure, by Theo. V. Middle Latitude Sailing.	
As radius 90°	10.00000	As the diff. of lat. 306	2.48572
Is to the diff. of lat. 306	2.48572	Is to the diff. of long. 2694	3.43040
So is sec. of course $81^\circ 37'$	10.83626	So is co-sine mid. lat. $39^\circ 32'$	9.88720
To the distance 2099	3.32198		13.31760
NOTE. The log. of the departure above found 3.31760 is rather less than the log. of 2078=3.31765; but in finding the course by the departure, I have used the quantity found at the first operation, and shall do the same in all future calculations.		To tang. of course $81^\circ 37'$	10.83188

BY GUNTER.

Extend from the radius or 90° to $50^\circ 28'$ the complement of the middle latitude, on the line of sines; that extent will reach from the difference of longitude 2694, to the departure 2078, on the line of numbers.

2dly. Extend from the difference of latitude 306, to the departure 2078,

* If the place A be to the southward of D, the line AC should be set off upon the line CB, from C towards B.

on the line of numbers; that extent will reach from radius or 45° , to the course $81^\circ 37'$ on the line of tangents.

3dly. Extend from the course $81^\circ 37'$ to the radius 90° on the line of sines; that extent will reach from the departure 2078 to the distance 2099 miles on the line of numbers.

BY INSPECTION.

RULE. Look for the middle latitude, as if it was a course in Plane Sailing, and the difference of longitude in the distance column, opposite to which, in the column of latitude, will stand the departure; having the difference of latitude and departure, the course and distance are found (as in Case VI. Plane Sailing) by seeking in Tab. II. with the difference of latitude and departure, until they are found to agree in their respective columns; opposite to them will be found the distance in its column, and the course will be found at the top of that table, if the departure be less than the difference of latitude, otherwise at the bottom.

Thus with one tenth of the difference of longitude 269.4 or 269, I enter Table II. and opposite to it, in the distance column of the Tables of 39° and 40° , I find 209.1 and 206.1 in the latitude column: now the middle latitude being nearly $39\frac{1}{2}^\circ$, I take the mean of these, 207.6 for the departure, which being multiplied by 10, gives the whole departure 2076. Again, I enter Table I, with one tenth of the departure 207.6, and one tenth of the difference of latitude 30.6 and find that they agree nearly to a course of $7\frac{1}{2}$ points, and a distance of 210, which multiplied by 10, gives the sought distance 2100 miles nearly.

CASE II.

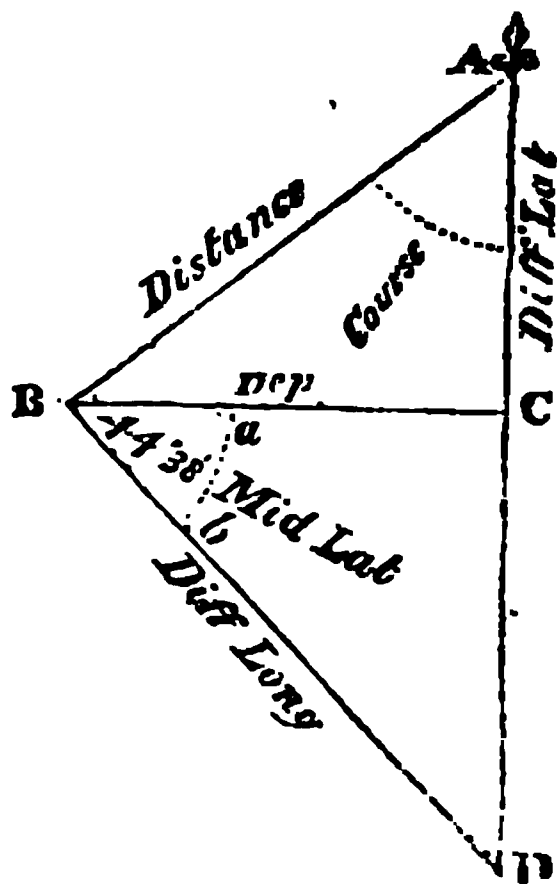
Both latitudes and departure from the meridian given, to find the course, distance, and difference of longitude.

A ship in the latitude of $49^\circ 57' N.$ and longitude of $15^\circ 16' W.$ sails south-westerly till her departure is 789 miles, and latitude in $39^\circ 20' N.$ Required the course, distance and longitude in?

Latitude left	$49^\circ 57' N.$
Latitude in	$39^\circ 20' N.$
Diff. of lat.	$10^\circ 37' = 637 \text{ miles}$
Sum of lats.	$79^\circ 17'$
Middle lat.	$44^\circ 38'$

BY PROJECTION.

Draw the meridian ACD, on which take AC equal to the difference of latitude 637 miles; draw CB perpendicular to AC, and make it equal to the departure 789 miles; about B as a centre describe an arch ab, on which set off the middle latitude $44^\circ 38'$; through B and b draw the line BD, meeting ACD in D; join AB and it is done; for AB will be the distance sailed, which being measured will be found = 1014 miles; BD will be the difference of longitude = 1109 miles, and the angle CAB will represent the course from the meridian $51^\circ 5'$.



BY LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of lat. 637	2.80414	As sine course $51^\circ 5'$	9.89101
Is to radius 45°	10.00000	Is to the departure 789	2.89708
So is the departure 789	2.89708	So is radius 90°	10.00000
To tang. course $51^\circ 5'$	10.09294	To the distance 1014	3.00607
To find the difference of longitude.			
As co-sine mid. latitude $44^\circ 38'$	9.85225	Longitude sailed from	$15^\circ 16' W.$
Is to the departure 789	2.89708	Diff. Long. 1109 miles	$18^\circ 29' W.$
So is radius 90°	10.00000	Longitude in	$33^\circ 45' W.$
To diff. of long. 1109	3.04483		

MIDDLE LATITUDE SAILING.

71

BY GUNTER.

1st. The extent from the difference of latitude 637 to the departure 789, on the line of numbers, will reach from radius, or 45° , to the course $51^\circ 5'$ on the line of tangents.

2^{dly}. The extent from $51^\circ 5'$ to radius, or 90° , on the line of sines, will reach from the departure 789, to the distance 1014 on the line of numbers.

3^{dly}. The extent from the complement of middle latitude $45^\circ 22'$, to radius, or 90° , on the line of sines, will reach from the departure 789 to the difference of longitude 1109 on the line of numbers.

BY INSPECTION.

RULE. With the difference of latitude and departure, find the course and distance (as in Case VI. of Plane Sailing) by seeking in Tab. II. until the difference of latitude and departure are found to correspond, against which in the distance column will be the distance; and if the departure be less than the difference of latitude, the course will be found at the top of that table, otherwise at the bottom.

Then take the middle latitude as a course, and find the departure in the latitude column, the number corresponding in the distance column will be the difference of longitude.

In the present example, I take one tenth of the difference of latitude 637, and the departure 789; that is 63,7 and 78,9 the nearest numbers to these are 63,6 and 78,5, standing together over 51° , against the distance 101, which being multiplied by 10 gives 1010; whence the course by inspection is S. 51° W. and the distance 1010. Then I take one tenth of the departure, 78,9 and seek it in the column of latitude of 45° (which is the nearest to the middle latitude $44^\circ 38'$), the nearest number I find is 79,2, opposite which in the distance column stands 112, which being multiplied by 10 gives 1120 for the difference of longitude; this value differs a little from that found by logarithms, owing to the miles of middle latitude neglected, for if we were also to find the difference of longitude for the middle latitude 44° and proportion for the minutes, the result would come out nearly the same as by logarithms.

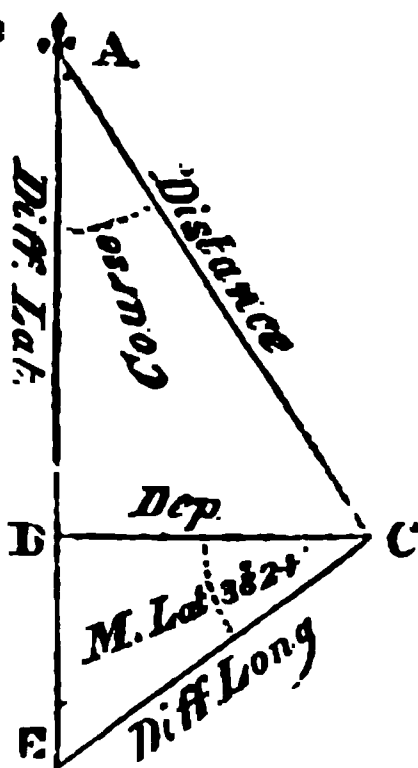
CASE III.

One latitude, course and distance given, to find the difference of latitude and difference of longitude.

A ship in the latitude of $42^\circ 30'$ N. and longitude $52^\circ 51'$ W. sails S. E. by S. 591 miles. Required the latitude and longitude in?

BY PROJECTION.

Draw the meridian ADE (as in case I. Plane Sailing) upon A as a centre describe an arch with the chord of 60° , and upon it set off, from where it cuts AD, the course S. E. by S. or 3 points, through that point of the arch, and the point A, draw the line AC, which make equal to the distance 591 miles; from C let fall upon AD the perpendicular CD; then will CD be the departure 328 miles, and AD the difference of latitude 491 miles. Hence we obtain the latitude arrived at, and the middle latitude; draw the line CE making an angle with DC of $38^\circ 24' =$ the middle latitude; and the distance CE will be the difference of longitude 419 miles. hence the longitude in is obtained.



BY LOGARITHMS.

To find the difference of latitude.		To find the departure.	
As radius 8 pts.	10.00000	As radius 8 pts.	10.00000
Is to the distance 591	2.77159	Is to the distance 591	2.77159
So is co-sine course 3 pts.	9.91985	So is sine course 3 pts.	9.74474
To the diff. of lat. 491.4	2.69144	To the departure 328.3	2.51633
Latitude left 42° 30' N.		To find diff. long. with departure.	
Diff. of lat.	8 11 S.	As co-sine mid. lat. 38° 24'	9.89415
Latitude in	34 19 N.	Is to the departure 328.3*	2.51633
Sum of lats.	76 49	So is radius 90°	10.00000
Middle lat.	38 24	To diff. of long. 419 miles	2.62218
Long. left	58° 51' W.	Without the departure.	
Diff. of long. 419=6 59 E.		As co-sine mid. lat. 38° 24' ar. co.	0.10583
Longitude in	51 52 W.	Is to sine course 3 pts.	9.74474
		So is distance 591	2.77159
		To diff. of long. 419 miles	2.62218

BY GUNTER.

- 1st. The extent from radius 8 points to the complement of the course 5 points on the line marked SR, will reach from the distance 591 to the difference of latitude 491 on the line of numbers.
- 2dly. The extent from radius 8 points to the course 3 points on the line SR. will reach from the distance 591 to the departure 328 on the line of numbers.
- 3dly. The extent from the complement of middle latitude 51° 36' to radius 90° on the line of sines, will reach from the departure 328 to the difference of longitude 419 on the line of numbers.

BY INSPECTION.

RULE. With the course and distance find the difference of latitude and departure (as in Case I. of Plane Sailing) by finding the given course at the top or bottom of the Tables, either among the points or degrees; in that page and opposite the distance taken in its column, will stand the difference of latitude and departure in their columns. Then take the middle latitude as a course and find the departure in the latitude column, against it, in the distance column will stand the difference of longitude.

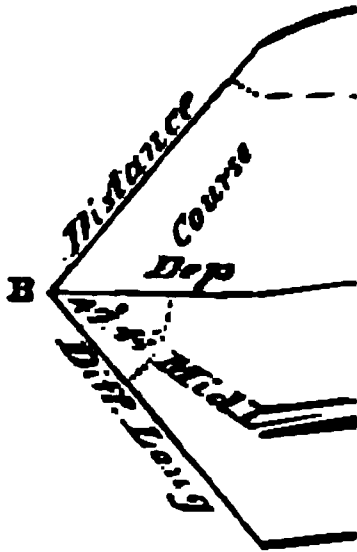
Thus, under the course three points, or S. E. by S. and against the tenth on the distance 591=59,1 or 59 stand 49,1 and 32,8; these multiplied by 10 give 491 for the difference of latitude and 328 for the departure. Now taking the middle latitude 38° 24' or 38° as a course, and a tenth of the departure 328=32,8 in the column of difference of latitude (the nearest is 33,1) against which stands 42 in the distance column; this multiplied by 10 gives 420 the difference of longitude nearly.

CASE IV.

Both latitudes and course given, to find the departure, distance and difference of longitude.

Suppose a ship sailing from a place in the latitude of 49° 57' N. and longitude of 30° W. makes a course good of S., 39° W. and then by observation is in the latitude of 45° 31' N.—it is required to find the distance run, and longitude in?

Latitude from	49° 57' N.
Lat. by observation	45 31 N.
	<hr/>
	4 26
	60
	<hr/>
Diff. lat.	268
	<hr/>
Sum of lats.	95° 28'
Mid. lat.	47 44



* The logarithm of the departure was found by the preceding canon to be 2.51633, differing from the logarithm of 328.3.

MIDDLE LATITUDE SAILING.

73

BY PROJECTION.

Draw the meridian ACD, on which set off AC equal to the difference of latitude 266 miles; draw CB perpendicular to AC; draw the line AB, making an angle equal to the course 39° with AC, and meeting BC in B; through B draw BD, making an angle equal to the middle latitude $47^{\circ} 44'$ with the line BC, and it is done; for AB will be the distance 342.3 miles, BC the departure 215.4 miles, and BD the difference of longitude 320.3 miles.

BY LOGARITHMS.

To find the departure.		To find the difference of longitude by the departure.	
As radius 45°	10.00000	As co-sine mid. lat. $47^{\circ} 44'$	9.82775
Is to the diff. of lat. 266	2.42483	Is to the departure 215.4	2.33325
So is tang. course 39°	9.90337	So is radius 90°	10.00000
To the departure 215.4	2.33325	To the diff. of long. 320.3	2.50550
To find the distance.		The diff. of long. may be found without the departure, by Theo IV. mid. lat. sailing, thus:	
As co-sine of the course 39°	9.89050	As co-sine mid. lat. $47^{\circ} 44'$	9.82775
Is to the diff. of lat. 266	2.42483	Is to tang. of course 39°	9.90337
So is radius 90°	10.00000	So is the diff. of lat. 266	2.42483
To the distance 342.3	2.53438		12.33325
To find the longitude in.			9.82775
Longitude sailed from $30^{\circ} 0' W.$		To the diff. of long. 320.3	2.50550
Diff. long. 320 miles or $5 20 W.$			
Longitude in $35 20$			

BY GUNTER.

1st. The extent from radius 45° to the course 39° on the line of tangents, will reach from the difference of lat. 266 to the departure 215.4 on the line of numbers.

2dly. The extent from the complement of the course 51° to the radius 90° on the line of sines, will reach from the difference of latitude 266 to the distance 342.3 on the line of numbers.

3dly. The extent from the complement of the middle latitude $42^{\circ} 16'$ to radius 90° on the line of sines, will reach from the departure 215.4 to the difference of longitude 320.3 on the line of numbers.

BY INSPECTION.

Find the course among the points or degrees (in Tab. I. or II. as in Case II. Plane Sailing) and the difference of latitude in its column, against which will stand the distance and departure in their columns; then take the middle latitude as a course, and find the departure in the latitude column, against which, in the distance column, will stand the difference of longitude.

Thus, with the course 39° , and half the difference of latitude 133, I enter Table II. the nearest number in the table is 132.9, which corresponds to the distance 171, and to the departure 107.6; these doubled give the distance 342, and the departure 215.2 miles.

Then with the mid. lat. $47^{\circ} 44'$ or 48° as a course, I enter Table II. and seek for half the departure 107.6 in the lat. col. the nearest number to which is 107.7, which corresponds to the distance 161; this doubled gives the diff. of long. 322 miles nearly.

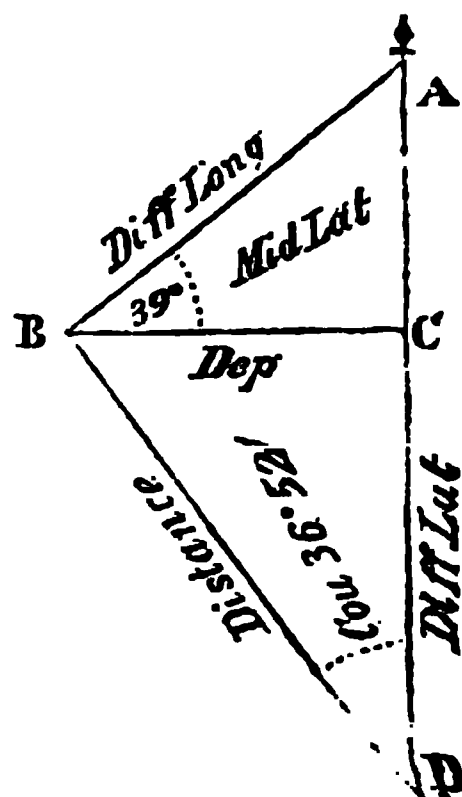
CASE V.

Both latitudes and distance given, to find the course, departure, and difference of longitude.

Suppose a ship sails 300 miles north-westerly, from a place in the latitude of $37^{\circ} N.$ and the longitude of $32^{\circ} 16' W.$ until she is in the latitude of $41^{\circ} N.$ —required her course and longitude in?

Latitude left $37^{\circ} 0' N.$	37° 0' N.
Latitude in $41 0$	41 0
4 0	Sum 78 0
60	Mid. lat. 39 0
Diff. lat. 240	

M



BY PROJECTION.

Draw the meridian ACD, on which set off DC equal to the difference of latitude 240 miles; draw the line CB perpendicular to DC; take the distance 300 in your compasses, and with one foot in D, as a centre, sweep an arch cutting CB in B; join DB; make the angle CBA equal to the middle latitude 39° and draw BA cutting DCA in A, and it is done; for BC will be the departure 180 miles, BA the difference of longitude 231.6 miles, and the angle BDC will represent the angle of the ship's course with the meridian, which will therefore be N. $36^{\circ} 52'$ W.

BY LOGARITHMS.

To find the course.

As the distance 300	2.47712
Is to radius 90°	10.00000
So is diff. lat. 240	2.38021
To co-sine course $36^{\circ} 52'$	9.90309

To find the departure.

As radius 90°	10.00000
Is to the distance 300	2.47712
So is sine course $36^{\circ} 52'$	9.77812
To the departure 180.0	2.25521

To find the difference of longitude by the departure.

As co-sine mid. lat. 39°	9.89050
Is to the departure 180.0	+2.25524
So is radius 90°	10.00000
To diff. of long. 231.6	2.36474

To find the longitude in.

Longitude left	$32^{\circ} 16' \text{ W.}$
Diff. of long.	3 52 W.
Longitude in	36 8 W.

BY GUNTER.

1st. The extent from the distance 300 to the difference of latitude 240 on the line of numbers, will reach from radius 90° to the complement of the course $= 53^{\circ} 8'$, on the line of sines.

2dly. The extent from radius 90° to the course $36^{\circ} 52'$ on the line of sines, will reach from the distance 300 to the departure 180 on the line of numbers.

3dly. The extent from the complement of the middle latitude 51° to the radius 90° on the line of sines, will reach from the departure 180 to the difference of longitude 231.6 on the line of numbers.

BY INSPECTION.

Find the course (as in Case IV. Plane Sailing) by seeking in Table II. till against the distance taken in its column, is found the difference of latitude in one of the following columns; adjoining to it will stand the departure; which if less than the difference of latitude, the course is to be found at the top of the Table, but if greater, at the bottom; then take the middle latitude as a course, and find the departure in the column of difference of latitude, against which, in the distance column, will stand the difference of longitude.

Thus the distance 300, and the difference of latitude 240, are found to correspond nearly to a course of 37° , and a departure of 180.5: then taking the middle latitude 39° as a course, I seek the departure 180.5 in the latitude column, corresponding to which, in the distance column, is the difference of longitude 232.

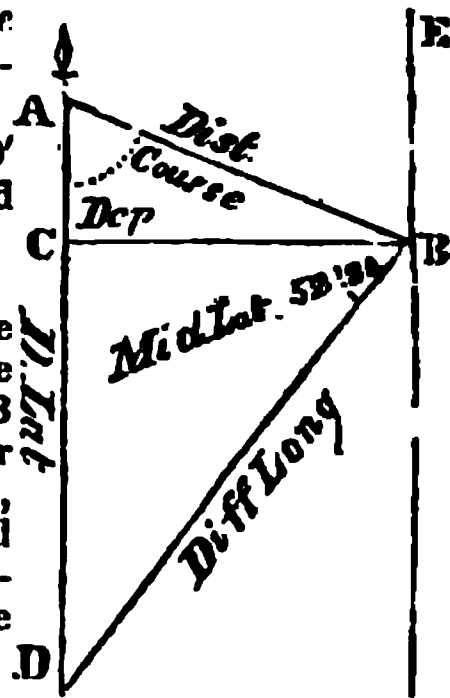
CASE VI.

(One latitude, course, and departure given, to find the difference of latitude, distance, and difference of longitude.)

A ship in the latitude of $50^{\circ} 10' \text{ S.}$ and longitude of $30^{\circ} 00' \text{ E.}$ sails E. S. E. until her departure is 957 miles; required her distance sailed, and latitude and longitude in?

BY PROJECTION.

Draw the meridian ACD, and parallel thereto at a distance equal to the departure 957 miles, draw the line EB; make the angle CAB equal to the course 6 points, and draw AB meeting EB in B; from B let fall upon AD the perpendicular BC; then will AC be the difference of latitude 396.4 miles, and AB the distance sailed 1036 miles; having thus obtained the middle latitude $53^{\circ} 29'$, make the angle CBD equal thereto, and draw BD meeting ACD in D; then will BD be the difference of longitude 1608 miles.



* This logarithm, by the preceding operation, was found equal to 2.25521, differing a little from the logarithm of 180.0.

MIDDLE LATITUDE SAILING.

75

BY LOGARITHMS.

To find the diff. of latitude.		To find the distance.	
As radius 4 points	10.00000	As sine course 6 points	9.96562
Is to the departure 957	2.98091	Is to the departure 957	2.98091
So is co-tang. course 6 points	9.61722	So is radius 8 points	10.00000
To the diff. of lat. 396,4	2.59813	To the distance 1036	3.01529
Latitude left	50° 10' S.	To find the diff. of longitude.	
Diff. of lat. 396 miles	6 36 S.	As co-sine mid. lat. 53° 28'	9.77473
Latitude in	56 46 S.	Is to the departure 957	2.98091
Sum of latitudes	106 56	So is radius 90°	10.00000
Middle latitude	53 28	To the diff. of long. 1608	3.2061*
Longitude left		30° 00' E.	
Diff. of long. 1608	=	26 48 E.	
Long. in		56 48 E.	

BY GUNTER.

1st. The extent from the course 6 points to the radius 4 points, on the line marked TR, will reach from the departure 957, to the difference of latitude 396,4 on the line of numbers.

2dly. The extent from 6 points to the radius or 8 points, on the line marked SR, will reach from the departure 957, to the distance 1036, on the line of numbers.

3dly. The extent from the complement of the middle latitude 36° 32' to the radius 90°, on the sines, will reach from the departure 957, to the difference of longitude 1608, on the line of numbers.

BY INSPECTION.

Find the course among the points or degrees, Tab. I. or Tab. II. (as in Case III. Plane Sailing) and the departure in its column, corresponding to which, in the columns of distance and difference of latitude, will be found the distance and difference of latitude respectively; then with the middle latitude as a course, seek the departure in the column of latitude, corresponding to which, in the distance column, will stand the difference of longitude.

Thus, I enter Table I. above E. S. E. or 6 points, and seek for one-tenth of the departure 95.7, the nearest to which is 96,1, and the corresponding numbers are 104 and 39,8, which multiplied by ten gives the distance 1040 and the difference of latitude 398 nearly; the middle latitude being nearly 53½°, I seek in the Table of 53° for the distance corresponding to a tenth of the departure = 95,7 and find it to be 159; then I seek for the same number 95,7 in the Table of 54°, and find the number corresponding in the distance column to be 163, half the sum of these two numbers is 161, which multiplied by 10 gives the difference of longitude 1610 nearly.

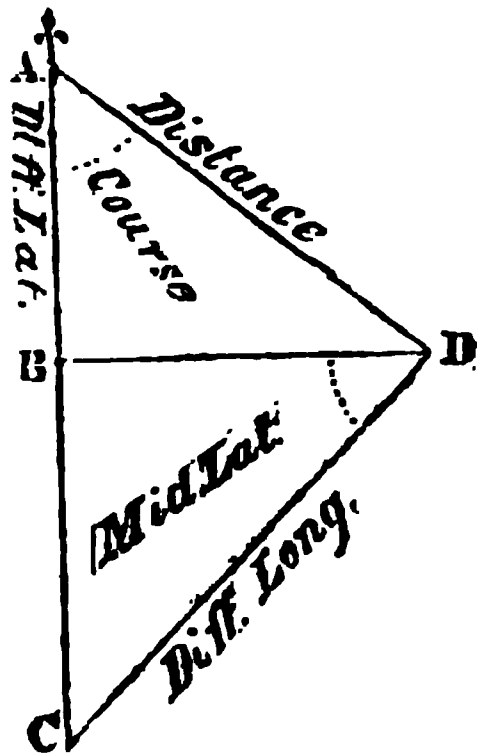
CASE VII.

One latitude, distance sailed, and departure from the meridian given, to find the course, difference of latitude, and difference of longitude.

A ship in the latitude of 49° 30' N. and longitude of 25° 0' W. sails south-easterly 645 miles until her departure from the meridian be 500 miles; required the course steered, and the latitude and longitude the ship is in?

BY PROJECTION.

Draw the line BD equal to the departure 500 miles, and perpendicular thereto draw the meridian line ABC; take an extent equal to the distance 645 in your compasses, and with one foot in D as a centre, describe an arch cutting AB in A. join AD, then will AB be the difference of latitude 407,5 miles, and BAD the course, S. 50° 48' E. Hence we have the latitude in, and middle latitude; make the angle BDC equal to the middle latitude and draw DC cutting ABC in C, then DC will be the difference of longitude 721.1 miles.



MIDDLE LATITUDE SAILING.

BY LOGARITHMS.

To find the course.	Latitude left
As the distance 645	2.50956 Diff. of lat. 406
As radius 90°	10.00000
As the departure 500	2.69897 Latitude in
To sine-course 50° 49'	9.38841 Sum of the latitudes
To find the difference of latitude.	Middle latitude
As radius 90°	10.00000
As to the distance 645	2.50956
As to sine-course 50° 49'	9.50058
To the diff. of lat. 407.5	2.61014
To find the difference of longitude.	Longitude left
As co-sine mid. lat. 46° 6'	9.54046 Diff. long. 721
As to the departure 500	2.69897
As to radius 90°	10.00000 Longitude in
To the diff. of long. 721.1	2.55799

BY GUNTER.

1st. The extent from the distance 645. to the departure 500 of numbers, will reach from the radius 90°. to the course 50° 4 of sines.

2dly. The extent from radius 90°. to the complement of the 11', on the line of sines. will reach from the distance 645 to 1 of latitude 407.5 on the line of numbers.

3dly. The extent from the complement of the middle latitude to the radius 90° on the line of sines. will reach from the departure the difference of longitude 721.1, on the line of numbers.

BY INSPECTION.

As in Case V. Plane Sailing. find the course by seeking in against the distance, in its column, is found the given departure following columns, adjoining to which in the other column will be found the difference of latitude, which if greater than the departure the course will be found at the top, but if less the course will be found at the bottom. Then find the middle latitude as a course, and find the departure in the column of latitude, against which, in the distance column, will be found the difference of longitude.

Thus, one-third of the distance, 215. and one-third of the departure, 166. are found nearly to correspond to a course of 51 degrees, and a difference of latitude of 135.3, which multiplied by 3 gives the sought difference of latitude 406 nearly; then with the middle latitude, 46°, as a course, in the Table, and seek for one-fifth of the departure=100. in the column of latitude, the distance corresponding, 144, being multiplied by 5 gives the difference of longitude 720 nearly.

QUESTIONS FOR EXERCISE.

Question I. Required the bearing and distance between two ships in the latitude of 37° 55' N. and longitude of 54° 23' W. the other in the latitude of 32° 38' N. and longitude of 17° 5' W.!

Answer. S. 80° 8' E. and N. 80° 49' W. distance 1854 miles

Question II. Required the direct course and distance, from a ship in the latitude of 36° 55' S. and longitude of 20° 0' E. to another in the latitude of 32° 38' S. and longitude of 8° 54' W.!

Answer. N. 79° 46' W. distance 1447 miles.

Question III. A ship from the latitude of 37° 30' S. and longitude of 55° 50' E. sails N. 79° 56' W. 202 miles; required the latitude and longitude.

Answer. Latitude 36° 55' S. longitude 55° 50' E.

Question IV. A ship from the latitude of 34° 35' N. and longitude of 45° 16' W. sails S. 85° 36' E. 101 miles; required her latitude and longitude.

Answer. Latitude 34° 24' N. longitude 43° 14' W.

MERCATOR'S SAILING.

THE calculations by Middle Latitude Sailing are sufficiently exact for a short run, or a day's work, and are to be preferred in all cases where the difference of latitude is small in comparison of the difference of longitude; but this method is liable to great errors in calculating the situations of places differing greatly in latitude and longitude, particularly in high latitudes; to remedy this inconvenience, a chart was invented and published in the year 1566. by GERARD MERCATOR, a Flemish Geographer, in which all the meridians are parallel to each other, but proportionally lengthened so as to conform to the spherical figure of the earth. The principles on which this chart is constructed were first explained in the year 1599, by Edward Wright, an Englishman, and are as follows.

By Theorem II. of Parallel Sailing, the distance of two meridians corresponding to a degree or mile of longitude, in any latitude, is to the length of a corresponding degree or mile of the meridian, as the co-sine of the latitude is to the radius, that is (*by Art. LVI. Geo.*) as radius is to the secant of the latitude. Hence, if the meridians are supposed to be parallel to each other, or the distance of the meridians to remain the same in every latitude, the degree or mile of latitude must be increased in proportion to the secant of the latitude. Therefore, if the radius be supposed to be equal to one mile, the length of the first mile of latitude from the equator will be represented by the secant of 1', the second mile by the secant of 2', the third mile by the secant of 3', &c. Therefore the length of the expanded arch of the meridian may be found by a continual addition of secants, to every degree and minute of the quadrant, as in Table III. by means of which the chart (called Mercator's chart) may be constructed, and all the cases of Mercator's Sailing may be projected and calculated.*

In using this table, the degrees are to be found at the top or the bottom, and the miles at the side; in the angle of meeting will be the length of the corresponding expanded arch, usually called the *meridional parts*. If you wish to find the arch of the expanded meridian intercepted between any two parallels, or, as it is usually called, the *meridional difference of latitude*, you must, when both places are on the same side of the equator, subtract the meridional parts of the lesser latitude from the meridional parts of the greater, the remainder will be the meridional difference of latitude; but if they are on different sides of the equator, the sum of the meridional parts of both latitudes will be the meridional difference of latitude required.

EXAMPLE I.

Required the meridional parts corresponding to the latitude of $42^{\circ} 34'$?

Look in the bottom or top of the table for 42° , marked 42 d. and in the right or left hand column marked (M) for 34', under the former and opposite the latter stand 2828, the meridional parts corresponding to $42^{\circ} 34'$.

EXAMPLE II. Required the Meridional difference of latitude between Cape Cod, in the lat. of $42^{\circ} 5'$ N. and the Island of St. Mary, in the latitude of $36^{\circ} 59'$ N.?

Cape Cod's lat. $42^{\circ} 5'$ N. Mer. parts 2785
St. Mary's lat. $36^{\circ} 59'$ N. Mer. parts 2391

Meridional difference of latitude

EXAMPLE III. Required the meridional difference of latitude between a place in the lat. of $35^{\circ} 12'$ N. and the Cape of Good Hope, in the latitude of $34^{\circ} 26'$ S.?

Lat. $35^{\circ} 12'$ N. Mer. par. 2259
C. of G. Hope's lat. $34^{\circ} 26'$ S. Mer. par. 2203

Sum is meridional difference of lat. 4462

From these principles it follows, that in sailing upon any course, the true proper difference of latitude is to the departure as the meridional difference of latitude is to the difference of longitude. Hence if MI (in the figure of case I. following) be the proper difference of latitude, IO the departure,

The manner of constructing this chart will be particularly explained hereafter. It may be observed, that the smaller the subdivisions of the arch of the meridian are, the greater will be the accuracy of the calculated length of the expanded arch of the meridian. To be perfectly accurate the arch ought to be divided into the smallest quantities possible. Attention was paid to this circumstance in calculating the above-mentioned Table.

MO the distance, the angle IMO the course, and we take MT equal to the meridional difference of latitude, and draw TH parallel to IO to cut MO continued in H; the line TH will represent the difference of longitude: for (by Art. LIII. Geom.) $MI : IO :: MT : TH$. Now in the triangle MTH, by making MT radius, we have $MT : \text{radius} :: TH : \text{tang. TMH}$, that is the meridional difference of latitude is to radius, as the difference of longitude is to the tangent of the course. By making MH or TH radius we shall have other analogies, which combined with those in Plane Sailing, furnish the solutions of the various cases of Mercator's Sailing contained in the following table.

MERCATOR'S SAILING.

Case.	Given.	Sought.	SOLUTIONS.
1	Both Latitudes and Longitudes.	Course. Distance. Departure.	Having both lats. the mer. diff. lat. is found by Table III. Mer. Diff. Lat. : Rad. :: Diff. Long. : Tang. Course. { Rad. : Prop. Diff. Lat. :: Secant Course : Distance. { Co-Sine Course : Prop. Diff. Lat. :: Rad. : Distance. { Rad. : Prop. Diff. Lat. :: Tang. Course : Departure. { Mer. Diff. Lat. : Diff. Long. :: Prop. Diff. Lat. : Depart.
2	Both Latitudes and Departure.	Course. Distance. Diff. Long.	Merid. Diff. Lat. being found by Table III. we have Prop. Diff. Lat. : Radius :: Departure : Tang. Course. { Radius : Prop. Diff. Lat. :: Sec. Course : Distance. { Sine Course : Departure :: Radius : Distance. { Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. :: Mer. Diff. Lat. : Diff. Long.
3	One Latitude, Course and Distance.	Departure. Diff. Lat. Diff. Long.	Radius : Distance :: Sine Course : Departure. Rad. : Dist. :: Co-sine Course : Prop. Diff. Lat. Hence we have the other latitude and mer. diff. lat. by Table III. Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long.
4	Both Latitudes and Course.	Distance. Departure. Diff. Long.	Co-sine Course : Prop. Diff. Lat. :: Rad. : Dist. Rad. : Prop. Diff. Lat. :: Tang. Course : Departure. Mer. diff. lat. being found in Table III. we have Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long.
5	Both Latitudes and Distance.	Course. Departure. Diff. Long.	Dist. : Rad. :: Prop. Diff. Lat. : Co-sine Course. Radius : Distance :: Sine Course : Departure. Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long.
6	One Latitude, Course and Departure.	Diff. Lat. Distance. Diff. Long.	Rad. : Dep. :: Co-tang. Course : Prop. Diff. Lat. Hence we have the other latitude and mer. diff. latitude. Sine Course : Departure :: Radius : Distance. { Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. :: Mer. Diff. Lat. : Diff. Long.
7	One Latitude, Distance and Departure.	Course. Diff. Lat. Diff. Long.	Dist. : Rad. :: Dep. : Sine Course. Rad. : Dist. :: Co-sine Course : Diff. Lat. Hence we obtain the other latitude and meridian difference latitude. { Rad. : Mer. Diff. Lat. :: Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. :: Mer. Diff. Lat. : Diff. Long.

CASE I.

The latitudes and longitudes of two places given, to find the direct course and distance between them.

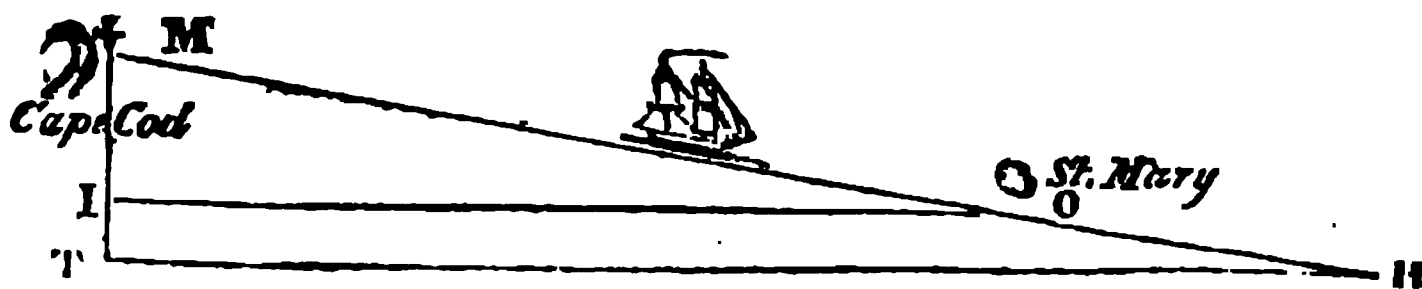
Required the bearing and distance from Cape Cod Light House in the latitude of $42^{\circ} 5' N.$ and longitude $70^{\circ} 4' W.$ to the island of St. Mary, one of the Western Islands, in the latitude of $36^{\circ} 59' N.$ and longitude of $25^{\circ} 10' W.$?

Cape Cod's lat. $42^{\circ} 5' N.$	Meridional parts 2788	Long. $70^{\circ} 4' W.$
St. Mary's lat. $36^{\circ} 59' N.$	Meridional parts 2391	$25^{\circ} 10' W.$
<u>5 6</u>	<u>Mer. diff. lat. 397</u>	<u>44 54</u>
60		60

Distance of lat. 306 miles.

Diff. of long. 2694 miles.

BY PROJECTION.



MERCATOR'S SAILING.

721

Draw the meridian MT equal to the meridional difference of latitude 397 miles, set off also upon it MI equal to the proper difference of latitude 306 miles; perpendicular to MT draw TH and IO, make TH equal to the difference of longitude 2694 miles, draw MH cutting IO in O; then will the angle TMH be the course S. $81^{\circ} 37'$ E. and OM the distance 2099 miles.

BY LOGARITHMS.

To find the course.

As the mer. diff. of lat. 397

Is to radius 45°

So is the diff. of long. 2694

To tang. of course $81^{\circ} 37'$

2.59879

10.00000

3.43040

10.83161

To find the distance.

As radius 90°

Is to the proper diff. of lat. 306

So is secant of course $81^{\circ} 37'$

To the distance 2099 miles

10.00000

2.48572

10.83626

3.32198

BY GUNTER.

1st. Extend from the meridional difference of latitude 397 to the difference of longitude 2694 on the line of numbers; that extent will reach from the radius or 45° , to the course $81^{\circ} 37'$ on the line of tangents.

2dly. Extend from the complement of the course $8^{\circ} 23'$ to radius 90° on the line of sines, that extent will reach from the proper difference of latitude 306, to the distance 2099 on the line of numbers.

BY INSPECTION.

With the meridional difference of latitude and difference of longitude used as difference of latitude and departure, find the course, by inspecting the tables until those numbers are found to correspond; with this course and the proper difference of latitude, find the corresponding distance.

Thus one tenth of the merid. diff. lat. and diff. long. are found to agree nearly to a course of $7\frac{1}{2}$ points; this course and one tenth of the proper difference of latitude 30,6 is found to correspond to the distance 209; this multiplied by 10 gives the distance 2090, differing a little from the result by logarithms, owing to the neglect of a few minutes in the course.

CASE II.

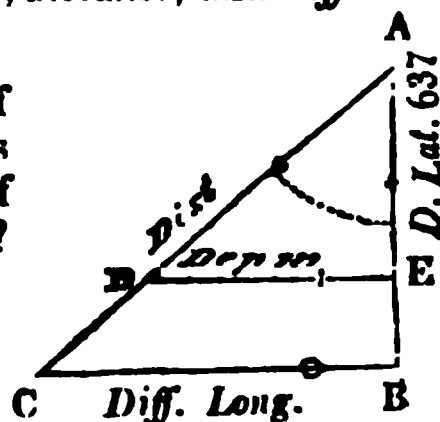
Both latitudes and the departure given, to find the course, distance, and difference of longitude.

A ship in the latitude of $49^{\circ} 57'$ N. and longitude of $15^{\circ} 16'$ W. sails south-westerly until her departure is 789 miles, and then by observation is in the latitude of $39^{\circ} 20'$ N. required her course, distance and longitude in?

Lat. left $49^{\circ} 57'$ N. Mer. parts 3470

Lat. in $39^{\circ} 20'$ N. Mer. parts 2571

Diff. lat. $10^{\circ} 37' = 637$ m. Mer. diff. lat. 899



BY PROJECTION.

With the proper difference of latitude and departure, project as in Case VI. Plane Sailing, by drawing the meridian AEB, on which take AE equal to the proper difference of latitude 637 miles; erect ED perpendicular to AE and make it equal to the departure 789 miles; join AD and continue it towards C: make AB equal to the meridional difference of latitude 899 miles, and draw BC perpendicular to AB, to cut AC in C, and it is done. For AD will be the distance 1014 miles, BC the difference of longitude 1114 miles, and the angle BAC will be the course S. $51^{\circ} 5'$ W.

BY LOGARITHMS.

To find the course.

As the proper diff. of lat. 637

Is to radius 45°

So is the departure 789

To tang. course $51^{\circ} 5'$

To find the diff. of long.

As radius 45°

Is to mer. diff. of lat. 899

So is tang. course $51^{\circ} 5'$

To diff. of long. 1114

2.80414

10.00000

2.89708

10.09294

10.00000

2.95376

10.09294

3.04670

To find the distance.

As radius

Is to prop. diff. of lat. 637

So is sec. course $51^{\circ} 5'$

To the distance 1014

Longitude left

Diff. of long. 1114

Longitude in

The diff. of long. may also be found by saying, as prop. diff. of lat. : dep. :: mer. diff. lat. : diff. of long.

10.00000

2.80414

10.20191

3.00605

$15^{\circ} 16'$ W.

$18^{\circ} 34'$ W.

$33^{\circ} 50'$ W.

BY GUNTER.

1st. The extent from the diff. of lat. 637 to the dep. 739 on the line of numbers, will reach from radius 45° to the course 51° 5' on the line of tangents.

2^{dly}. The extent from the course 51° 5' to radius 90° on the sines, will reach from the departure 739 to the distance 1014 on the line of numbers.

3^{dly}. The extent from the radius 45° to the course 51° 5' on the line of tangents, will reach from the merid. diff. of lat. 899 to the difference of longitude 1114 on the line of numbers.

BY INSPECTION.

Find the course by Plane Sailing. Case VI. by seeking in the tables with the proper difference of latitude and departure till they are found to agree in their respective columns. corresponding to which will be the distance in its column, and the course will be found at the top of that column if the departure is less than the proper difference of latitude, otherwise at the bottom; with the same course, find the meridional difference of latitude in the latitude column. corresponding to which in the departure column will be the true difference of longitude.

Thus with one tenth of the true difference of latitude and departure 63,7 and 73,9, I find the course 51°, and the distance 101. which multiplied by 10 gives nearly the true distance 1010; in the same table, opposite to one tenth of the meridional difference of latitude 89,9 I find the departure 111,1, which multiplied by 10 gives the difference of longitude 1111 miles.

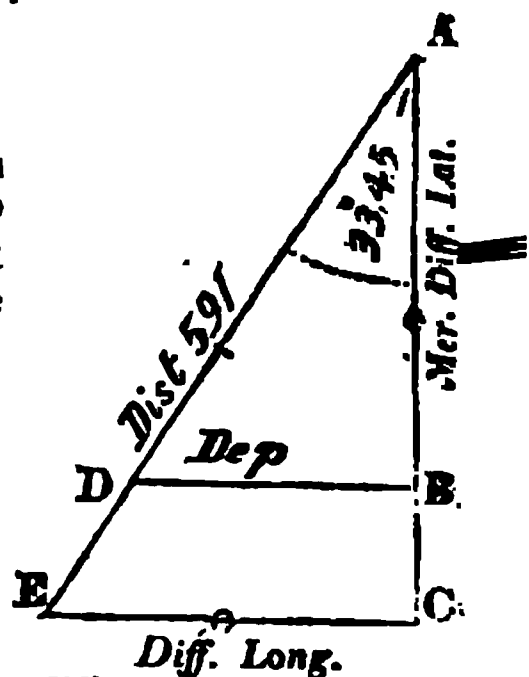
CASE III.

One latitude, course and distance given, to find the difference of latitude and difference of longitude.

A ship in the latitude of 42° 30' N. and longitude of 58° 51' W. sails S. W. — by S. 591 miles; required the latitude and longitude in?

BY PROJECTION.

Draw the meridian ABC, and ADE, making an angle with it equal to the course 3 points, make AD equal to the distance sailed, 591 miles, and from D let fall upon AB the perpendicular BD: then will BD be the departure, and AB the difference of latitude, 491 miles. Hence we have both latitudes, and the meridional difference of latitude, to which make AC equal, and draw CE parallel to BD meeting ADE in E, then will CE be the difference of longitude, 419,6 miles.



BY LOGARITHMS.

To find the diff. of latitude.		To find the diff. of longitude.	
As radius 8 points	10.00000	As radius 4 points	10.00000
Is to the distance 591	2.77159	Is to the mer. diff. of lat. 628	2.79796
So is co-sine course 3 points	9.91985	So is tang. course 3 points	9.82489
To prop. diff. lat. 491.4	2.69144	To diff. of long. 419.6	2.62285
Lat. left 42° 30' N. Mer. parts 2922		Long. left 58° 51' W.	
Diff. Lat. 491=8 11 S.		Diff. of long. 420= 7 00 W.	
Lat. in 34 19 N. Mer. parts 2194		Long. in 65 51 W.	
Mer. diff. lat. 628			

BY GUNTER.

1st. The extent from radius 8 points to the complement of the course 5 points, on the line marked SR, will reach from the distance 591 to the difference of latitude 491.4 on the line of numbers.

2^{dly}. The extent from the radius 4 points to the course 3 points, on the line marked TR, will reach from the meridional difference of latitude 628 to the difference of longitude 419.6 on the line of numbers.

MERCATOR'S SAILING.

81

BY INSPECTION.

As in Case I. Plane Sailing, find the course at the top or bottom of the tables, either among the points or degrees, and in that page, opposite the distance, will be found the difference of latitude and departure in their respective columns. Then in the same table find the meridional difference of latitude in the latitude column; corresponding to which, in the departure column, will be the difference of longitude.

Thus, under the course S. W. by S. or 3 points, and opposite one third of the distance 197, stands 163.8 in the latitude column, which multiplied by 3 gives the difference of latitude 491.4 miles; then find one fourth of the meridional difference of latitude 157 in the latitude column, against which stands 105 in the departure column, which multiplied by 4 gives 420 the difference of longitude.

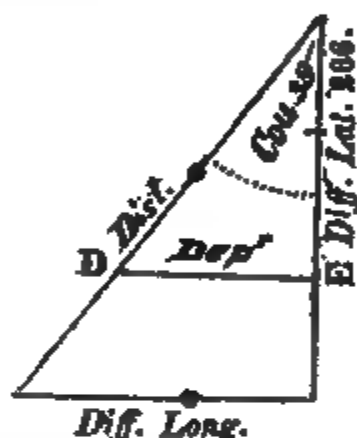
CASE IV.

Both latitudes and course given, to find the distance and difference of longitude.

A ship from the latitude of $49^{\circ} 57' N.$ and longitude of $30^{\circ} W.$ sails S. $39^{\circ} W.$ till she arrives in the latitude of $45^{\circ} 31' N.$ Required the distance run and longitude in?

Lat. left $49^{\circ} 57' N.$ Mer. parts 3470
Lat. in $45^{\circ} 31' N.$ Mer. parts 3074

Diff. lat. $4^{\circ} 26' = 266$ m. Mer. diff. lat. 396 miles.



BY PROJECTION.

Draw the meridian AEB, on which take AE equal to the proper difference of latitude 266 miles, and AB equal to the meridional difference of latitude 396 miles; make the angle BAC equal to the course 39° , and draw ED, BC, perpendicular to AB, cutting ADC in D and C; then will AD be the distance 342 miles, and BC the difference of longitude 321 miles.

BY LOGARITHMS.

To find the distance.		To find the diff. of longitude.	
As the co-sine course 39°	9.89050	As radius 45°	10.00000
Is to the prop. diff. of lat. 266	2.42488	Is to mer. diff. of lat. 396	2.59770
So is radius 90°	10.00000	So is tang. course 39°	9.90837
To the distance 342.3		2.53438	To the diff. of long. 320.7
Longitude left $30^{\circ} 0' W.$		2.50607	
Diff. of long. $321 = 5^{\circ} 21' W.$			
Longitude in, $35^{\circ} 21' W.$			

BY GUNTER.

1st. The extent from the complement of the course 51° to the radius 90° on the sines, will reach from the proper difference of latitude 266, to the distance 342.3 on the line of numbers.

2dly. The extent from radius 45° to the course 39° on the line of tangents, will reach from the meridional difference of latitude 396, to the difference of longitude 321 on the line of numbers.

BY INSPECTION.

As in case II. Plane Sailing, find the course among the points or degrees and the proper difference of latitude in its column, adjoining to which will be the distance and departure in their respective columns; then in the same table, find the merid. diff. of lat. in the lat. column, adjoining to which in the departure column, will be the difference of longitude.

Thus, under the course 39° and opposite the half diff. of lat. 133 (the

nearest to which is 132.9) stand 171 and 107.6, these doubled give the distance 342 and departure 215.2; and in the same table opposite the mer. diff. of lat. 198 found in the latitude column, stands 160.5 in the departure column, which doubled gives the difference of longitude 321 miles, near as before.

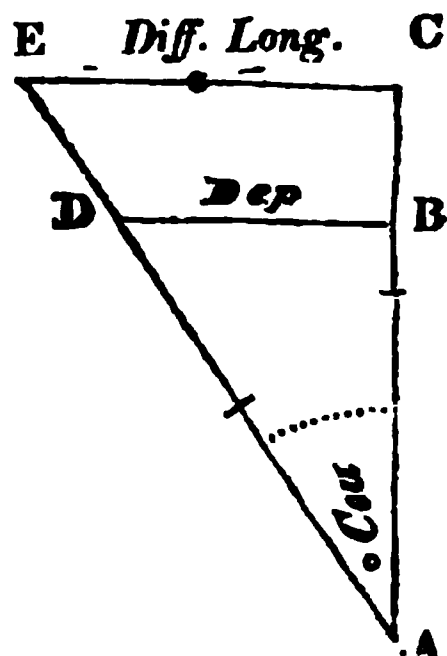
CASE V.

Both latitudes and distance given, to find the course, and difference of longitude.

A ship from the latitude of 37° N. and longitude of $32^{\circ} 16'$ W. sails 300 miles north-westerly, until she is in the latitude of 41° N. Required the course steered and longitude in?

Lat. left 37° N.	Mer. parts 2393
Lat. in 41° N.	Mer. parts 2702

Diff. lat. $4^{\circ} = 240$ miles. Mer. diff. lat. 309 miles.



BY PROJECTION.

Draw the meridian ABC; make AB equal to the proper difference of latitude 240, and AC equal to the meridional difference of latitude 309 miles; draw BD and CE perpendicular to ABC; with an extent equal to the distance 300 in your compasses, and one foot in A as a centre, describe an arc cutting BD in D; draw AD, which continues to cut CE in E, and it is done for the angle BAD is equal to the course of $36^{\circ} 52'$, BD is the departure and CE is the difference of longitude 231.7 miles.

BY LOGARITHMS.

To find the course.		To find the diff. of longitude.	
As the distance 300	2.47712	As radius 45°	10.00
Is to radius 90°	10.00000	Is to the mer. diff. of lat. 309	2.48
So is prop. diff. of lat. 240	2.38021	So is tang. course $36^{\circ} 52'$	9.87
<hr/>		<hr/>	
To co-sine course $36^{\circ} 52'$	9.90309	To the diff. long. 231.7	2.36
Longitude left		$32^{\circ} 16'$ W.	
Diff. of longitude 232 =		3 52 W.	
Longitude in		36 08 W.	

BY GUNTER.

1st. The extent from the distance 300 to the proper difference of latitude 240, on the line of numbers, will reach from the radius or 90° to 53° the complement of the course on the line of sines.

2dly. The extent from radius 45° to the course $36^{\circ} 52'$ on the line tangents, will reach from the meridional difference of latitude 309 to difference of longitude 231.7, on the line of numbers.

BY INSPECTION.

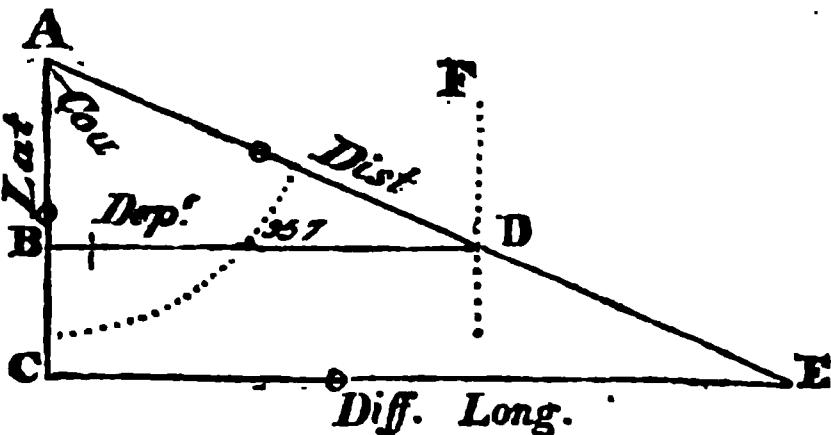
As in Case IV. Plane Sailing, seek in the table till against the distance taken in its column is found the given difference of latitude in one of the following columns; adjoining to it will stand the departure, which if less than the difference of latitude, the course will be found at the top, otherwise at the bottom; in the same table find the meridional difference of latitude in the latitude column, adjoining to which in the departure column will stand the difference of longitude.

Thus the distance 300 and the difference of latitude 240, are found to correspond to a course of 37° , and a departure of 180.5; and in the latitude column, opposite half the meridional difference of latitude 154.5 (the nearest to which is 154.1) stands 116.2 in the departure column, which doubled gives the difference of longitude 232.4.

CASE VI.

One latitude, course and departure given, to find the distance, difference of latitude, and difference of longitude.

A ship from the latitude of $50^{\circ} 10' S.$ and longitude of $30^{\circ} E.$ sails E. S. E. until her departure is 957 miles; required the distance sailed, and the latitude and longitude in?



BY PROJECTION.

Draw the meridian ABC, and at a distance from it equal to the departure 957 miles, draw the line FD parallel to ABC; make the angle BAD equal to the course 6 points, draw AD to cut FD in D; from D let fall upon AB the perpendicular DB; then will AD be the distance 1036 miles, AB the difference of latitude 396 miles; hence we have both latitudes, and the meridional difference of latitude 667 miles, make the line AC equal thereto, and draw CE perpendicular to AC meeting AD continued in E; then will CE be the difference of longitude 1610 miles.

BY LOGARITHMS.

To find the distance.		Lat. left	$50^{\circ} 10' S.$	Mer. parts	3490
As the sine course 6 points	9.96562	Diff. lat. $396' = 6^{\circ} 36' S.$			
Is to the departure 957	2.98091	Lat. in	$56^{\circ} 46' S.$	Mer. parts	4157
So is radius 8 points	10.00000				
To the distance 1036	3.01529			Merid. diff. of lat.	667
To find the diff. of lat.		As radius 4 points			10.00000
As radius 4 points	10.00000	Is to the merid. diff. of lat. 667			2.82413
Is to the departure 957	2.98091	So is tang. course 6 points			10.38278
So is co-tang course 6 points	9.61722	To diff. long. $1610' = 26^{\circ} 50' E.$			3.20691
To prop. diff. of lat. 396.4 miles	2.59813	Long. left	$30^{\circ} 00' E.$		
		Long. in	$56^{\circ} 50' E.$		

BY GUNTER.

- 1st. The extent from the course 6 points to radius 8 points on the line marked S. R. will reach from the departure 957 to the distance 1036 on the line of numbers.
- 2dly. The extent from radius 4 points to the complement of the course 3 points, on the line marked T. R. will reach from the departure 957 to the difference of latitude 396 on the line of numbers.
- 3dly. The same extent (from the radius 4 points to the course 6 points on the line marked T. R.) will reach from the meridional difference of latitude 667, to the difference of longitude 1610, on the line of numbers.

BY INSPECTION.

As in Case III. Plane Sailing, find the course either in Table I. or Table II. and the departure in its column, corresponding to which will stand the distance and difference of latitude in their respective columns: in the same Table find the meridional difference of latitude, in the latitude column, corresponding to which, in the departure column, will be found the difference of longitude.

Thus, over the course E. S. E. or 6 points, and against one-fifth of the departure 191.4 stand 79.2 and 207, which multiplied by 5 give the difference of latitude 396 miles, and the distance 1035 miles; then in the latitude column find a tenth of the meridional difference of latitude 66.7, the nearest to that is 66.8, against which, in the departure column, stands 160.8, which multiplied by 10 gives 1608, the difference of longitude.

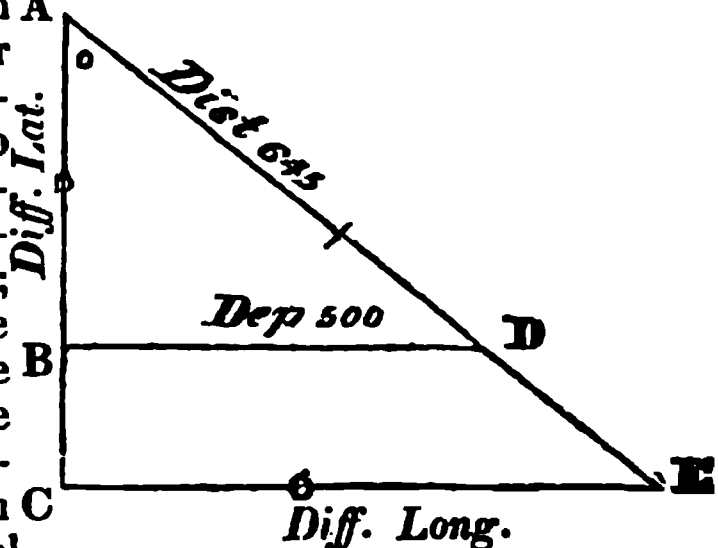
CASE VII.

One latitude, distance sailed, and departure given, to find the course, difference of latitude, and difference of longitude.

A ship in the latitude of $49^{\circ} 30' N.$ and the longitude of $25^{\circ} W.$ sails southeasterly 645 miles, making 500 miles departure; required the course steered, and the latitude and longitude in?

BY PROJECTION.

Draw the meridian ABC, and on A any point of it draw BD perpendicular thereto, and make it equal to the departure 500 miles; with an extent equal to the distance 645 miles in your compasses, and one foot on D as a centre describe an arch to cut AB in A, join AD; then will AB be the proper difference of latitude 407.5 miles, and the angle BAD will be the course $50^{\circ} 49'$; hence we have the other latitude, and the meridional difference of latitude, to which C make AC equal; and draw CE parallel to BD, meeting AD produced in E; then will CE be the difference of longitude, 722.6 miles.



BY LOGARITHMS.

To find the course.		To find the diff. of lat.	
As the distance 645	2.80956	As radius 90°	10.00000
Is to radius 90°	10.00000	Is to the distance 645	2.80956
So is the departure 500	2.69897	So is co-sine course $50^{\circ} 49'$	9.80058
To sine of course $50^{\circ} 49'$	9.88941	To diff. l. $407.5 = 6^{\circ} 48' S.$	2.61014
To find the diff. of long.		Lat. left	49 30 N. M. par. 3428
As radius 45°	10.00000	Lat. in	42 42 N. M. par. 2839
Is to mer. diff. of lat. 589	2.77012	Mer. diff. lat.	599
So is tang. course $50^{\circ} 49'$	10.08879	Long. left	25 00 W.
To diff. of long. 722.6	2.85891	Diff. long.	12 3 E.
Or thus:		Long. in	12 57 W.
As prop. diff. of lat. 407.5^*	2.61014	Hence the ship's course is S. $50^{\circ} 49' E.$	
Is to the departure 500	2.69897	Lat. in $42^{\circ} 42' N.$ Long. in $12^{\circ} 57' W.$	
So is the mer. diff. of lat. 589	2.77012		
	5.46909		
	2.61014		
To diff. of long. 722.7	2.85895		

BY GUNTER.

1st. The extent from the distance 645 to the departure 500 on the line of numbers, will reach from the radius 90° to the course $50^{\circ} 49'$ on the line of sines.

2dly. The extent from radius 90° to the complement of the course $39^{\circ} 11'$ on the line of sines, will reach from the distance 645 to the difference of latitude 407.5 on the line of numbers.

3dly. The extent from the radius 45° to the course $50^{\circ} 49'$ on the line of tangents, will reach from the mer. diff. of lat. 589 to the difference of longitude 722.6 on the line of numbers. Or, the extent from the proper difference of latitude 407.5 to the departure 500, will reach from the meridional difference of latitude 589 to the difference of longitude 722.7 on the line of numbers.

BY INSPECTION.

Find the course and difference of latitude, as in Case V. Plane Sailing, by seeking in Tab. II. till the distance and departure are found to correspond in their respective columns, adjoining to which, in the column of latitude, will

* This log. was found above—it differs a little from the log. of 407.5.

For find the true difference of latitude, which if greater than the departure the course will be found at the top; but if less, the course will be found at the bottom: with this course seek the meridional difference of latitude in the latitude column, adjoining to which in the departure column will be found the difference of longitude.

Thus one-third of the distance 215, and one-third of the departure 166.7 are found nearly to correspond to a course of 51 degrees, and a difference of latitude of 135.3, which multiplied by 3, gives the true difference of latitude 406 nearly. Then one-fourth of the meridional difference of latitude 147, in the latitude column, is found nearly to correspond to the departure 131.9; this multiplied by 4, gives 727.6 the difference of longitude nearly.

Having explained the method of calculating single courses by Middle Latitude and Mercator's Sailing, it now remains to explain the method of calculating compound courses. To do this, you must construct a Traverse Table, and find the difference of latitude and departure for each course and distance, as in Traverse Sailing, and from thence the whole difference of latitude, departure, and latitude in, with the departure and latitudes, find the difference of longitude and longitude in, as in Case II. of Middle Latitude or Mercator's Sailing.

This method is exact enough for working any single day's work at sea, except in high latitudes, where it will be a little erroneous; in this case the difference of longitude and longitude in, may be calculated for every single course and short distance; but in general this nicety in calculation may be neglected.

To illustrate the method of working compound courses, we shall here work an example, by Middle Latitude and Mercator's Sailing.

EXAMPLE.

TRAVERSE TABLE.

A ship from Cape Henlopen, in the latitude of $38^{\circ} 47'$ N. longitude $75^{\circ} 17'$ W. sails the following true courses, viz. E. by S. 20 miles, E. N. E. 15 miles, S. E. 26 miles, South 16 miles, W. S. W. 6 miles, N. W. 10 miles, and East 30 miles: required her latitude and longitude?

By constructing the Traverse Table with these courses and distances, it appears that the ship has made 27.8 miles of southing, and 69.3 miles of easting; and by subtracting the southing from the latitude of Cape Henlopen there remains the latitude in $38^{\circ} 19'$ N.

Courses.	Dist.	Diff.		Departure.	
		N.	S.	E.	W.
E. by S.	20		3.9	19.6	
E. N. E.	15	5.7		13.9	
S. E.	26		18.4	18.4	
South.	16		16.0		
W. S. W.	6		2.3		5.5
N. W.	10	7.1			7.1
East.	30			30.0	
		12.8	10.6	81.9	12.6
			12.8	12.6	
		D. Lat. 27.8		69.3 Dep.	

Cape Henlopen's latitude	$38^{\circ} 47'$ N.	Meridional parts	2529
Latitude in	$38^{\circ} 19'$ N.	Meridional parts	2492
Sum of latitudes	77 6		36
Middle latitude	38 33		

By inspection of Table II. it appears that the difference of latitude 27.8 and departure 69.3 correspond to a course of 68° nearly, and a distance of 75 miles; and in the same page of the Table opposite to the meridional difference of latitude, found in the column of latitude, stands the difference of longitude 89 miles in the departure column; this subtracted from the longitude of Cape Henlopen $75^{\circ} 17'$ W. leaves the longitude in $73^{\circ} 38'$ W. by Mercator's Sailing. Or, with the Middle Latitude $38^{\circ} 33'$ to 39° as a course, find the departure 69.3 in the latitude column, opposite to which is 89 in the distance column, which is the difference of longitude by Middle Latitude Sailing; consequently the longitude in is $73^{\circ} 38'$ W. as above.

Thus we see that such examples are performed as in Traverse Sailing and Case II. of Mercator's or Middle Latitude Sailing, either by Inspection, as above, or by the scale of logarithms.

Having gone through the necessary problems in Mercator's Sailing, we shall now show how Mercator's Chart may be constructed by means of the Table of Meridional Parts.

To construct a Mercator's Chart to commence at the Equator.

Suppose it was required to construct the Chart in the Plate prefixed to this work which begins at the equator, and reaches to the parallel of 50 degrees, and contains 95 degrees of longitude west from the meridian of Greenwich?

Draw the line AD representing the equator, then take from any scale of equal parts the number of minutes contained in 95 degrees, viz. 5700, which set off from A to D; subdivide this line into 95 equal parts representing degrees of longitude. Through A and D draw the lines AB, DC perpendicular to AD, and make each of them equal to 3474 which are the meridional parts, corresponding to 50 degrees. Join BC which must be subdivided in the same manner as the line AD; and through the corresponding points of the lines AD, BC must be drawn (at the distance of 10° or 20°) the lines parallel to AB, representing meridians of the earth; these lines must be numbered 0, 10, 20, &c. beginning at the line AB which represents the meridian of Greenwich. Set off in like manner upon the meridians AB, DC, (beginning from the equator AD) the meridional parts corresponding to each degree of latitude from 0° to 50° ; and through the corresponding points (at the distance of 10° or 20°) draw lines parallel to the equator AD, to represent the parallels of latitude. Then the upper part of the chart will represent the north, the lower the south, the right hand the east, and the left hand the west (which is generally supposed in charts, unless the contrary is expressly mentioned.)

If the Chart does not commence at the equator, but is to serve for a certain portion of the globe contained between two parallels of latitude on the same side of the equator, you must draw the meridians as directed in the last example; then subtract the meridional parts of the least latitude of the chart from the meridional parts of the other latitudes, and set off these differences on the extreme meridians, draw lines through the corresponding points, and they will be the parallels of latitude on the chart.

If the chart is to be bounded by parallels of latitude on different sides of the equator, you must draw a line representing the equator, and perpendicular to it draw the lines to represent the meridians, continuing them on both sides of the equator; then set off the parallels of latitude on both sides of the equator, in the same manner as in the first example.

Take from the Table of latitudes and longitudes of places the latitude and longitude of each particular place contained within the bounds of the chart, and lay a rule over its latitude and another crossing that over its longitude: the point where these meet will represent the proposed place upon the chart. The most remarkable point of a sea coast being thus laid down, lines may be drawn from point to point which will form the outlines of the sea coast, islands, &c. to which may be annexed the depths of water expressed in common Arabian numbers, the time of high water on the full and change days expressed in Roman numbers: the setting of the tide expressed by an arrow; and whatever else may be thought convenient for the chart to contain.

This chart is not to be considered as a just representation of the earth's surface, for the figures of islands and countries are distorted towards the poles, as is evident from the construction; but the degrees of latitude and longitude are increased in the same proportion, so that the bearings between places will be the same on the chart as on the globe; and as the meridians are right lines, it follows, that the rhumbs, which form equal angles with the meridians, will be straight lines, which render this projection of the earth's surface much more easy and proper for the mariner's use than any other.

Having the latitude and longitude of a ship or place, to find the corresponding point on the chart.

RULE. Lay a ruler across the chart in the given parallel of latitude: take

in your compasses the nearest distance between the given longitude and the nearest meridian drawn across the chart; put one foot of the compasses in the point of intersection of the ruler and meridian, and extend the other along the edge of the ruler on the same side of the meridian as the place lies, and that point will represent the place of the ship.

If the longitude on the chart be counted from a different meridian from that you reckon from, you must reduce the given longitude to the longitude of the chart, by adding or subtracting the difference of longitude of those meridians, and then mark off the ship's place as before directed. Or, you may draw a meridian line through the place you reckon your longitude from; then measure off the ship's longitude on the equator, and apply it to the edge of the ruler, from this meridian, and you will obtain the ship's place.

To find the bearing of any place from the ship.

RULE. Lay a ruler across the given place and the place of the ship; set one foot of the compasses in the centre of some compass near the ruler, and take the nearest distance to the edge of the ruler; slide one foot of the compasses along that edge keeping the other extended to the greatest distance from the ruler, and observe what point of the compass it comes nearest to, for that will be the bearing required.

To find the distance of any place from the ship.

RULE. Take the distance between the ship and given place in your compasses and apply it to the side of the chart or graduated meridian, setting one foot as much above one place as the other is below the other place, the number of degrees between the points of the compasses will be the distance nearly.

When the places bear north and south of each other this rule is accurate; but when they bear nearly east and west, and the distance is large, it will err considerably; but in general it is exact enough for common purposes; if greater accuracy is required, it is best to find the distance by calculation.

If any one wishes to estimate the distance accurately by the chart, he must proceed in the following manner:

1. If the place be in the same longitude that the ship is in, then the preceding rule is accurate.

2. If the place be in the same latitude as the ship, or bear east or west, the distance cannot be obtained without calculating it by Case I. of Parallel Sailing.

3. If the place be neither in the same latitude, nor in the same longitude as the ship, the distance must be found in the following manner: Lay a ruler over both places, and draw through one of them a parallel to the equator: take the difference of latitude between both places in your compasses from the equator; slide one foot on that parallel, keeping the other extended so that both points shall be on the same meridian, and note the point of the ruler which is touched by the other foot of the compasses, take the distance from this point to the given place through which the parallel was drawn and apply it to the equator, and you will have the sought distance.

The bearing and distance of any two places from each other may be found in the same manner as the bearing and distance of any place from the ship.

EXAMPLE.

Required the bearing and distance between the east end of Long-Island and the north part of Bermudas?

A ruler being laid over both places as directed in the preceding rule, it will be found to lay parallel to the N. W. by N. and S. E. by S. line; and the distance between the two places being taken in the compasses, and applied to the graduated meridian, will measure about 10 degrees or 600 miles: therefore these places bear from each other N. W. by N. and S. E. by S. and their distance is 600 miles nearly.

The Half-Minute Glass is of the same form as an Hour Glass, (see P Fig. 2) and contains such a quantity of sand as will run through the its neck in half a minute of time.

The making of the experiment to find the velocity of the ship heaving the log, which is thus performed. One man holds the reel, another the half-minute glass; an officer of the watch throws the line to the ship's stern, on the lee side, and when he observes the stray line off (which is about ten fathoms, this distance being usually allowed for the log out of the eddy of the ship's wake) and the first mark (which is generally a red rag) is going off, he cries *turn!* the glass holder cries *done!* who watching the glass, the moment it is run out says *stop!* the reel being immediately stopt, the last mark run off shows the number of knots, and the distance of that mark from the reel is estimated in fathoms. Then the knots and fathoms together, show the distance the ship has sailed in the preceding hour, if the wind has been constant. But if the gale has been the same during the whole hour, or time between heaving the log, there has been more sail set or handed, a proper allowance must be made. Sometimes when the ship is before the wind, and a great sea setting against it will bring home the log; in such cases it is customary to allow one knot in 10, and less in proportion if the sea be not so great: allowance ought to be made if there be a head sea.

This practice of measuring a ship's rate of sailing is founded upon the following principle: That the length of each knot is the same part of a mile, as half a minute is of an hour. Therefore the length of a knot ought to be $\frac{1}{120}$ of a sea mile; but by various admeasurements it has been found that the length of a sea mile is about 6120 feet; hence the length of a knot should be 51 feet: each of these knots is divided into 10 fathoms, each about 5 feet each. If the glass be only 28 seconds in running out, the length of the knot ought to be 47 feet and 6 tenths. These are the lengths generally recommended in books of navigation, but it may be observed, that in trials it has been found, that a ship will generally over-run her reckoning with a log-line thus marked; and since it is best to err on the safe side, it is generally recommended to shorten the above measures by 3 or 4 feet, so that the length of a knot about $7\frac{1}{2}$ fathoms of 6 feet each, to correspond with a glass that runs 28 seconds.

In heaving the log you must be careful to veer out the line as fast as will take it; for if the log is left to turn the reel itself, the log will come in and deceive you in your reckoning. You must also be careful to meas

be corrected in the following manner, supposing that a 30" glass requires 50 feet to a knot.

(1.) If the glass only is faulty, you must say, *as the seconds run by the glass are to 30 seconds, so is the distance given by the log to the true distance.*

Thus if a ship sails $8\frac{1}{2}$ knots per hour, by a glass of 33 seconds, the true number of knots per hour will be 7.1; for, $36 : 30 :: 8.5 : 7.1$.

(2.) If the log-line only is faulty, you must say, *as 50 feet is to the distance of a knot on the line, so is the distance run by the log to the true distance.* Thus, if a ship sails 7 knots per hour, by a log-line measuring 53 feet, her true distance will be 7.4 miles per hour, because, $50 : 53 :: 7 : 7.4$.

(3.) If the log-line and glass are both faulty, you must say, *as 50* multiplied by the length of the glass is to 30 multiplied by the length of the line, so is the measured to the true distance.* Thus, if a ship sails 6 knots per hour with a glass of 24 seconds, and a log-line of 60 feet per knot, her true velocity will be 9 miles per hour, because $50 \times 24 : 30 \times 60 :: 6 : 9$.



DESCRIPTION AND USE

OF A

QUADRANT OF REFLECTION.

MR. JOHN HADLEY was the first who published a description of the *Quadrant of Reflection*, for measuring angular distances, and the instrument still bears his name, although it has been ascertained that Sir Isaac Newton invented a similar one some years before, but never made it public: one of our countrymen, Mr. Thomas Godfrey, of Philadelphia, had also contrived an instrument on the same principles some time before Mr. Hadley made known his discovery.

Figure 1, Plate VII. represents a Quadrant of Reflection, the principal parts of which are, the frame ABC, the graduated arch BC, the index D, the nonius or vernier scale E, the index glass F, the horizon glasses G and H, the dark glasses or screens I, and the sight vanes K and L.

The graduated arch BC is an octant or eighth part of a circle, but on account of the double reflection is divided into 90° numbered from 0° towards the left, and each degree is commonly divided into three equal parts of 20 minutes each. The graduation on the limb is continued a few degrees to the right of 0° ; this portion is called the *arch of excess*, and is found very convenient for several purposes.

The index D is a flat bar commonly made of brass, moveable round the centre of the instrument, and broader towards the axis of motion, where is fixed the index glass F; at the other end is fixed the nonius or vernier scale, used in estimating the subdivisions of the arch; at the bottom or end of the index there is a piece of brass which leads under the arch, having a spring to make the vernier lie close to the limb, and a screw to fasten it in any position. Some quadrants have a tangent screw affixed to the lower part of the index to adjust its motion. The vernier is a small narrow slip of brass or ivory fixed to that part of the index which slides over the graduated arch, and usually contains a space equal to 21 or 19 divisions of the limb, and is divided into 20 equal parts; hence the difference between a division on the limb, and a division on the dividing scale, is one twentieth of a division of the limb, or one minute; therefore, if any division on the vernier is in the same straight line with a division of the limb, then no other division on the

* Instead of multiplying the length of the glass by 50, and the line by 30, you may multiply the former by 3, and the latter by 2. If any one chooses to mark the log line at less than 50 feet for a glass of 30 seconds he must put the estimated length of the knot instead of 50, in all the above rules.

vernier can coincide with a division of the limb, the extreme divisions excepted. Some time ago it was usual to reckon the divisions on the vernier from its middle towards the right, and from the left towards the middle: but this being found inconvenient, a more commodious method has been introduced of numbering from right to left: hence the degree and minute, pointed out by the vernier, may be found thus: observe what minute on the vernier coincides with a division on the limb, then this minute, being added to the degree and parts of a degree on the limb immediately preceding the first division on the vernier, will be the degree and minute required. Thus, suppose 10' on the vernier coincided with a division on the limb, and that the division on the limb preceding the first division of the vernier, was $2^{\circ} 20'$, the division pointed out by the vernier would be $2^{\circ} 30'$.

The *index glass* F, is a plane speculum or mirror of glass, quicksilvered and set in a brass frame; it is so placed that the face of it is perpendicular to the plane of the instrument, and is fixed to the index by the screw M; the other screw N serves to replace it in a perpendicular position, if by any accident it has been put out of order. The use of this mirror is to receive the rays from the sun, or other object observed, and reflect them towards the horizon glasses.

The *horizon glasses* G and H, are two small speculums—G is called the *fore horizon glass*, from its being used in the common or *fore observation*, where the observer's face is turned towards the object; and H the *back horizon glass*, being used in the *back observation*, where the observer's back is turned towards the object; these mirrors receive the reflected rays from the index glass and reflect them to the eye of the observer. The horizon glasses are not entirely quicksilvered: the fore-horizon glass G is only silvered on the lower half, the other part being transparent, and the back part of the frame cut away, that the horizon or any other object may be seen through it; the back-horizon glass H, is silvered at both ends; in the middle is a transparent slit, through which the horizon may be seen: these two glasses are set in brass frames similar to that of the index glass, and fixed on moveable bases, which are adjusted by screws so as to set the glasses in their true positions. In general there are three *dark glasses* or screens I, two red ones of different shades, and one green: each is set in a brass frame, which turns on a centre that they may be used separately or together: they serve to defend the eye from the rays of the sun during an observation. The green glass is peculiarly adapted to take off the glare of the moon, but may be used for the sun when much obscured by clouds. When these glasses are used for a fore-observation, they are to be fixed as in fig. I, but when used for a back-observation they are to be placed at O.

The *sight vanes*, K and L, are pieces of brass standing perpendicular to the plane of the instrument; the vane K is called the *fore-sight vane*, and L the *back-sight vane*. There are two holes in the fore-sight vane, the lower of which, and the upper edge of the silvered part of the fore-horizon glass are equi-distant from the plane of the instrument, and the other hole is opposite to the middle of the transparent part of that glass. The back-sight vane has one perforation which is exactly opposite to the middle of the transparent slit in the back-horizon glass.

The *adjusting-lever*, (fig. 2,) which is fixed on the back of the quadrant, serves to adjust the horizon glass, by placing it parallel to the index glass; when this lever is to be made use of, the screw B must be first loosened, and when by the adjuster A the horizon glass is sufficiently moved, the screw B must be fastened again, by which means the horizon glass will be kept from changing its position.

To adjust a quadrant.

As the quadrant, from various accidents, is liable to be out of order, it is necessary that the mariner should be able to ascertain the errors, and the several parts before he proceeds to make his observations. Suppose he must examine whether the index glass and the horizon glass be perpendicular to the plane of the instrument, and whether the fore-horizon glass be parallel, and that of the back-horizon glass

perpendicular to the plane of the index glass, when 0 on the vernier stands against 0 on the limb.

1st. *To ascertain whether the index glass be perpendicular to the plane of the Quadrant.*

Place the index on the middle of the arch, and hold the index glass near the eye, look into it, in a direction parallel to the plane of the instrument, and see if the reflected arch appear exactly in a line with the arch seen direct, or if the image of any point of the arch near B appear of the same height as the corresponding part of the arch near C seen direct, if so, the index glass is perpendicular to the plane of the quadrant: if not, the error must be rectified by the screws on the base behind the frame, by loosening the screw M, and tightening the screw N, or by loosening the screw N, and tightening the screw M.

2d. *To ascertain whether the fore-horizon glass be perpendicular to the plane of the Quadrant.*

Having adjusted the index glass, hold the instrument in a vertical position: look through the fore-sight vane, and move the index till the reflected and direct images of the horizon, seen in the horizon glass, coincide; then incline the instrument till its plane is nearly parallel to the horizon; if the images still coincide, the horizon glass stands perpendicular, otherwise it does not, and must be adjusted by the screws placed before and behind it, loosening one of them and tightening the other.

This adjustment may be made by the sun, moon, or star, by holding the quadrant in a vertical position, and observing if the object seen by reflection appears to the right or left of the object seen direct; and moving the screws as above till both images coincide.

After having made the horizon and index glasses parallel, according to the directions in the following article, it will be best to re-examine this adjustment.

3d. *To make the horizon glass parallel to the index glass when 0 on the vernier stands on 0 on the arch.*

Having fixed the index so that 0 on the vernier stands on 0 on the arch, look at any distant object and see if the image on it coincides with the object itself: if it does, the adjustment is complete: if not, they must be made to coincide by means of the adjusting lever. The horizon may be used for this purpose in the following manner: hold the plane of the instrument vertical, look through the lower hole in the vane K, and direct the sight through the transparent part of the Glass G to the horizon; then if the horizon line, seen in the silvered and transparent part, coincide, or makes one straight line, the horizon glass is said to be adjusted: but if the horizon lines do not coincide, slacken the screw B (fig. 2) in the middle of the adjusting lever, and turn the horizon glass on its axis until the horizon lines coincide, then fix the lever firmly by tightening the screw B. If this adjustment be again examined, it will perhaps be found imperfect; in this case, therefore, it remains either to repeat the adjustment, or find the error of it usually called the *index error*, which may be done thus.—Let the horizon glass remain fixed, and move the index till the image and object coincide, then the difference between 0 on the vernier and 0 on the arch is the index error, which is to be added to the angle or altitude observed, if the 0 on the vernier be to the right hand of 0 on the arch, otherwise to be subtracted. Thus if the horizon was used, the instrument being held in a vertical position, you must look through the lower hole of the vane K, towards the horizon; then move the index till the reflected and direct images of the horizon coincide, the difference between 0 on the vernier and 0 on the arch will be the index error.

4th. *To adjust the back-horizon glass, that it may be perpendicular to the plane of the index glass, when 0 on the vernier stands on 0 on the arch.*

Set the index as far to the right of 0 on the arch as twice the dip of the horizon (taken from Table XIII.) hold the quadrant in a vertical position,

look towards the horizon through the hole in the back horizon vane L, and the transparent slit of the back horizon glass H, then if the reflected horizon, which will appear inverted, coincide with that seen direct, the glass is truly adjusted, otherwise the screw, in the centre of the lever on the under side of the quadrant, must be slackened, and the glass turned on its axis till both horizons coincide, when the lever should be fixed by tightening the screw.

5th. To adjust the back horizon glass that it may be perpendicular to the plane of the quadrant.

Put the index on 0: hold the quadrant nearly parallel to the horizon; look through the hole on the back sight vane, and if the true and reflected horizons appear in the same straight line, the glass is perpendicular to the plane of the instrument; but if they do not coincide, the sunk screws before and behind the glass must be turned till both appear to form one straight line.

To take an altitude of the Sun by a Fore Observation.

If the sun is bright, turn down one or more of the dark glasses; hold the instrument in a vertical position; apply the eye to the upper hole in the fore-sight vane, when the image is so bright as to be seen in the transparent part of the fore-horizon glass, otherwise to the lower hole; direct the sight to that part of the horizon beneath the sun, and move the index till you bring the image of his lower limb to touch the horizon directly under him; but as this point cannot be exactly ascertained, the observer should move his instrument round to the right and left a little, keeping as nearly as possible the sun always in that part of the horizon glass, which is at the same distance as the eye from the plane of the quadrant,* by which motion the sun will appear to sweep the horizon, and must be made to touch it at the lowest part of the arch; the degrees and minutes pointed out by the index will be the observed altitude of the sun's lower limb at that instant.

To take an altitude of the Moon by a Fore Observation.

In the night when the moon is bright, her image may be seen in the transparent part of the fore-horizon glass, and the observation may be taken exactly in the same manner as an observation of the sun. If the image is so faint as not to be seen in the transparent part of the horizon glass, you must set the index to 0, hold the plane of the quadrant in a vertical position, direct the sight to the moon, and at the same time look for her reflected image in the silvered part of the horizon glass; move the index forward till the moon's image, which will appear to descend, just touches the horizon, then sweep the quadrant as in observing the sun, and bring her round limb into contact with the horizon, whether it be her upper or lower. The degrees and minutes pointed out by the index will be the observed altitude of that limb which was brought in contact with the horizon.

To take an altitude of a Star by a Fore Observation.

This is done exactly in the same manner as in observing the moon's altitude when her image is so faint as not to be seen in the transparent part of the horizon glass.

To take the Sun's altitude by a Back Observation.

Put the dark glasses in the hole O, and turn one or more of them down, according to the brightness of the sun; then, holding the instrument in a vertical position, look through the back sight vane towards that part of the horizon opposite the sun; move the index till the sun's image is seen in the silvered part of the glass; give the quadrant a slow vibratory motion and the sun will appear to describe an arch with its convex side upward; bring the upper limb, when in the upper part of this arch, in contact with that part of the horizon seen through the transparent slit, and the degrees and minutes

* In common quadrants, if the upper hole be looked through, the sun's image must be made to appear in the middle of the transparent part of the horizon glass, but if the lower hole be looked through, the image must be made to appear on the line joining the silvered and transparent parts of the horizon glass, as these parts of the horizon glass are at the same distances from the plane of the instrument as the holes in the sight vanes respectively.

pointed out by the index, will be the altitude of the sun's lower limb. The altitude of the moon or a star, may be obtained in the same manner, only observing to bring the round edge of the moon to the horizon.

The back observation is but little used on account of the difficulty of adjusting and observing: various remedies have been proposed for these defects, but none have yet been generally adopted. The back observation of the altitude of any object is useful only when there is not an open horizon for the fore observation; but even in that case the fore observation might often be used, if the distance of the horizon was known, as will be explained farther on.

To take the meridian altitude of any celestial object by a Fore Observation.

When the object rises and sets, it comes to the meridian above the horizon only once in 24 hours, and is then at its greatest altitude, by observing which, the latitude may be easily determined. The sun comes to the meridian exactly at noon or 12 o'clock: the moon and stars at various hours. To observe the meridian altitude, begin a few minutes before the time of passing the meridian; bring the object to sweep the horizon according to the preceding directions; this must be repeated until the object begins to descend below the edge of the sea; the degrees and minutes then shewn by the index will be the meridian altitude.

If the object does not set, it comes to the meridian below the pole, and is then at its least altitude; this altitude may be observed as above directed with this difference, that you must continue sweeping till the object begins to rise above the edge of the sea, instead of descending below it.

The meridian altitude of any object may be taken in a similar manner by a back observation.

Strictly speaking, this method of finding the meridian altitude is absolutely accurate, only when the ship is at rest and the sun's declination constant. For if the ship is sailing towards the sun, the altitude will be increased, and it will be decreased if sailing from the sun; but the correction of altitude arising from this source is very small, and may be neglected in all nautical calculations, as will be shown hereafter.

Advice to Seamen in the choice of a Quadrant.

The joints of the frame must be close, without the least opening or looseness, and the ivory on the arch inlaid and fixed, so as not to rise in any place above the plane of the instrument; all the divisions of the arch and vernier must be exceedingly fine and straight, so that no two divisions of the vernier (except the first and last) coincide at the same time with the divisions of the arch. All the glasses belonging to the quadrant should have their surfaces perfectly plane, and their fore and back surfaces exactly parallel; the first of these requisites in the horizon glass and index glass may be thus verified by means of two distant objects: move the index till both objects are exactly in contact, at the upper edge of the silvered part of the horizon glass, then move the quadrant in its own plane so as to make the united images move along the line, separating the silvered from the transparent part of the horizon glass, and if in this motion the images continue united, the reflecting surfaces are good planes, otherwise the planes are imperfect. The parallelism of the two surfaces of the reflecting glasses may also be examined by viewing the image of some object reflected very obliquely, for if that image appears single and well defined about the edges, it is a proof that the surfaces are parallel; on the contrary, if the edge of the reflected image appears as if it threw a faint shadow from it, or separated like two edges, it is evident that the two surfaces of the glass are inclined to each other; if the image be the sun, and viewed through a small telescope, the examination will be more perfect. To examine the dark glasses, you must bring the image of a distant object to coincide with the object seen direct; then turn the coloured glass so that the plane which was next to the index glass may now be next to the horizon glass, and if the direct and reflected images still coincide, the surfaces of the glass are parallel.

DESCRIPTION AND USE OF A SEXTANT OF REFLECTION.

A SEXTANT is constructed on the same principles, and may be used for measuring altitudes, in the same manner, as a quadrant.* The arch of a sextant, as its name implies, contains 60° , but by reason of the double reflection, is divided into 120° . This instrument is particularly intended to measure the distance of the moon from the sun, or a fixed star, and as that distance is wanted as accurately as possible, to determine the longitude of the place of observation, the instrument is constructed with more care, and is provided with some additional appendages that are wanting in the quadrant. Fig. 3, Plate VII. represents a sextant, the frame of which is generally made of brass, or other hard metal, the handle at its back is made of wood; by this, when observing, the instrument is to be held with one hand, while the other is moving the index. The arch AA. is divided into 120° , each degree into three parts of 20 minutes each, and the vernier scale is in general so divided as to shew half minutes. In some sextants, the degree is divided into 6 equal parts of $10'$ each, and the vernier shows $10''$.

In order to observe with accuracy, and make the images come precisely in contact, a *tangent screw* B is fixed to the index, by which it may be moved with greater regularity than it can be by hand; but this screw does not act until the index is fixed by the screw C at the back of the sextant. Care should be taken not to force the tangent screw when it arrives at either extremity of its arch. When the index is to be moved any considerable quantity, the screw C must be loosened; but when the index is brought nearly to the division required, the back screw C should be tightened, and then the index moved gradually by the tangent screw.

In many sextants, the lower part of the index glass, or that next the plane of the instrument, is silvered as usual, and the back surface of the upper part painted black; a screen, painted black, is fixed by its axis to the base of the index glass, and may be placed over the silvered part when the rays are strong; in which case the image is to be reflected from the outer surface of the upper part, and the error which might probably arise from the planes of the glass not being parallel, is thereby avoided.

The coloured glasses are similar to those applied to a common quadrant, and are usually four in number, placed at D, to screen the eye from the solar rays and the glare of the moon; they may be used separately or together, as occasion requires. In addition to these, there are three similar glasses placed behind the horizon glass, to be used in finding the index error by means of the sun, and in observing the sun's altitude by an artificial horizon on land. The paler glass is sometimes used in observing altitudes at sea, to take off the strong glare of the horizon.

A sextant is generally furnished with a tube without glasses, and two tel-

* There is not in general any apparatus for the back observation fixed to a sextant, but if the altitude of any celestial object be greater than 90° , the supplement of the altitude may be obtained by a back observation with a sextant with ease and accuracy, and as this method may be often used with advantage when a fore observation cannot be obtained, we shall here point out the method of taking the observation, and shall hereafter give the calculations for determining the latitude from a meridian observation, taken in this manner.—The back of the observer being turned to the sun, he must move the index till the image of the sun touches the edge of the back horizon, and then move the sextant a little to the right and left (as in a fore observation); and the image will describe an arch with the convex side upward; move the index till the lower limb of the image, when in the upper part of the arch, just touches the horizon, and the observation will be complete; observing that, if the telescope be used, the image must be brought in the middle between the two parallel wires; but if the telescope be not used, the image of the sun must be seen in the horizon glass at the same distance from the plane of the instrument as the observer. The altitude thus obtained will be the supplement of the altitude of the sun's upper meridian; to be applied to obtain the true central altitude, will be given hereafter.

telescopes, the one representing the objects erect or in their natural situation, the other inverting them, the eye glass being fixed in a moveable tube in order to adjust the telescope to a proper focus. By means of these telescopes the line of sight may be rendered parallel to the plane of the instrument, and the contact of the limbs of any two objects more accurately observed. The tube, or either telescope, is to be screwed into a brass ring, which is connected with another brass ring, by means of two screws, and by loosening one and tightening the other, the axis of the tube, or telescope, may be set parallel to the plane of the instrument. One of these rings is fixed to a brass stem that slides in a socket, and by means of the screw L at the back of the sextant, it may be raised or lowered so as to move the axis of the telescope to point to that part of the horizon glass judged the most fit for observation.

A circular head, containing a plate, in which there are three coloured glasses, and a part that is open, sometimes accompanies the sextant: this head is to be screwed on the eye end of the tube, or on that of either telescope. The edge of the plate projects a little beyond the head on one side, and is moveable by the finger, so that the open ring or any of the coloured glasses, may be brought between the eye glass of the telescope and the eye; this answers the purpose of the dark glasses placed at E, in adjusting by the sun, or observing by an artificial horizon on land.

To these are added a small screw driver, to adjust the screws, and a magnifying glass to read off the observation with greater accuracy.

The adjustments of a sextant are similar to those of a quadrant; the index and horizon glasses must be perpendicular to the plane of the instrument, and their planes parallel to each other when the index stands on 0; also the axis of the telescope must be set parallel to the plane of the instrument: each of these particulars must be examined before an observation is taken, and the adjustments, if requisite, made according to the following directions.

1st. To set the index glass perpendicular to the plane of the instrument.

Move the index forward to about 60°, and proceed exactly in the manner prescribed for the adjustment of the index glass of a quadrant, page 91.

2d. To make the horizon glass perpendicular to the plane of the Sextant.

This adjustment is made exactly in the same manner, as that of the quadrant described in page 91, except that instead of looking through the sight vane, you may use the tube or a telescope.

To make the horizon glass and index glass parallel when the index is on 0.

Having made the foregoing adjustments, set the first division on the index to 0 on the limb, fasten the index in this position, and make the coincidence of these divisions as perfect as possible, by means of the tangent screw, the eye being assisted by the magnifying glass; screw the tube, or telescope, into its support, and turn the screw L at the back of the instrument, till the line which separates the transparent and silvered parts of the horizon glass appears in the middle of the tube or telescope; having done this, hold the plane of the sextant vertically and direct the sight through the tube or telescope to the horizon; then if the reflected and true horizons do not coincide, turn the tangent screw at the back of the horizon glass till they are made to appear in the same straight line. Then will the horizon glass be adjusted.

After the screw that retains the horizon glass in its place, is fastened, it will be proper to re-examine this adjustment; if the coincidence of the horizons is not perfect, the adjustment must be repeated till it is so; but as it is difficult to obtain a perfect coincidence by this means, the horizons may be brought to coincide by turning the tangent screw of the index, and the difference between the 0 on the arch and the 0 on the vernier will be the index error, which is additive to all observations, if the 0 of the index stand on the

extra arch, otherwise subtractive. The index error may also be found, very accurately, by measuring the diameter of the sun twice, with a motion of the index in contrary directions; that is, first bring the upper limb seen by reflection to coincide with the lower limb seen directly, then bring the lower limb by reflection to coincide with the upper seen directly. If both these measures are taken either to the right or left of 0 on the limb, half their sum will be the index error; additive if to the right of 0; subtractive, if to the left; but if one of the measures be taken to the right, and the other to the left of 0, half their difference will be the index error, which will be additive when the diameter measured to the right of 0 exceeds that measured to the left, otherwise subtractive. Thus if the measures were 38' to the left of 0 on the arch, and 26' to the right* on the extra arch, half the difference or 6' would be the correction, subtractive. In some sextants the horizon glass cannot be adjusted; the index error must in that case be found, and must be considered as a constant quantity to be applied to all angles measured with the same instrument.

To set the axis of the telescope parallel to the plane of the Sextant.

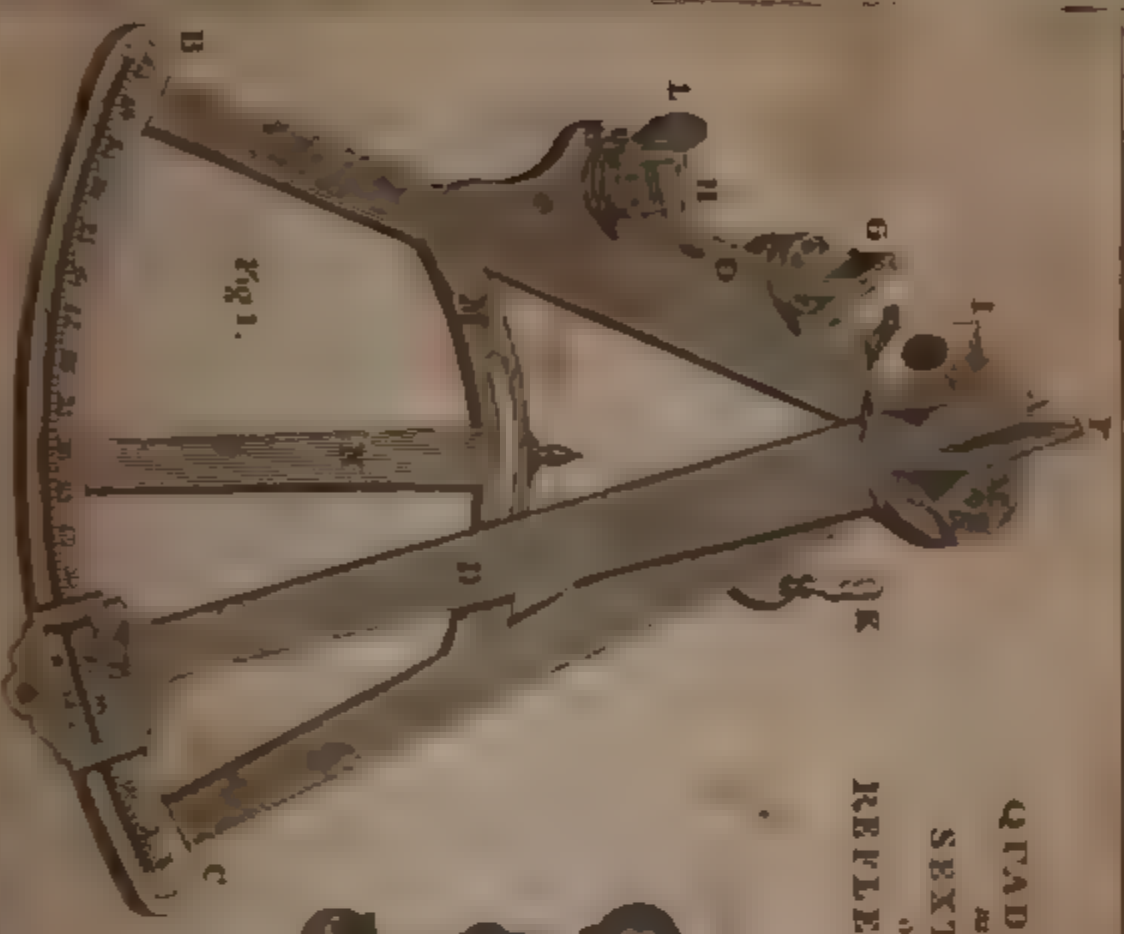
In measuring angular distances, the line of sight, or axis of the telescope, should be parallel to the plane of the instrument, as a deviation in that respect, in measuring large angles, would occasion a considerable error: to avoid which, a telescope is made use of, in which are placed two wires, parallel to each other, and equidistant from the centre of the telescope, by means of which, the adjustment may be made in the following manner.—Screw on the telescope and turn the tube containing the eye glass, till the wires are parallel to the plane of the instrument; then take two objects, as the sun and moon, whose angular distance must not be less than 90° , because the error is more easily discovered when the distance is great; bring them exactly into contact at the wire nearest the plane of the sextant, and fix the index; then, by altering a little the position of the instrument, make the image appear on the other wire; if the contact still remains perfect, the axis of the telescope is in its right situation; but, if the limbs of the two objects appear to separate or lap over, at the wire which is farthest from the plane of the sextant, the telescope is not parallel, and it must be rectified by turning one of the two screws of the ring into which the telescope is screwed and fixed, having previously unturned the other screw: by repeating this operation a few times, the contact will be precisely the same at both wires, and the axis of the telescope will be parallel to the plane of the instrument.†

In order to estimate the error committed in not observing the contact of the objects in the middle between the two parallel wires of the telescope, it is necessary to know the angular distance of these wires: this may be found as follows: Turn round the eye piece of the telescope, till the wires are perpendicular to the plane of the instrument: hold the instrument in a vertical position, and move the index till the direct and reflected images of the horizon appear in the same line, which will happen when the index is at 0 if the instrument be well adjusted; then move the index till the reflected image of the horizon be at one wire and the directed image at the other; the angle moved through by the index, as shown by the divisions of the arch, will be the an-

* In reading off the measure on the extra arch, you must reckon the minutes on the vernier from left to right, counting 19' as 1', 18 as 2', &c. or else take the difference between the minutes denoted by the vernier and 20'. Thus if the angle on the extra arch appeared by the nonius to be 14' the real angle would be only 6'.

† This adjustment may be made in a manner similar to that by which the graduation on the frame of the telescope of a circular instrument is verified by using the adjusting tools of a circle or a ruler whose surfaces are perfectly parallel to each other. Thus, lay the sextant horizontally on a table, and place the ruler on the limb or plane of the instrument, and, at about 12 or 15 feet distance, let a well defined mark be placed in a range with the telescope, so as to be in the same straight line with the top of the ruler, then raise or lower the telescope by means of the screw L. till the centre of the eye piece of the telescope be at the same height as the top of the ruler, then if the mark be seen in the middle between the wires of the telescope, it is well adjusted: if not, it must be altered by means of the screw turning into which the telescope is screwed.

QUADRANT
and
SEXTANT
of
REFLECTION.



gular distance of the two wires. This angular distance being obtained, the observer may, by means of it, estimate, at each observation, how much the place where the contact was observed, was elevated above, or depressed below, the plane passing through the eye and the middle line between the two parallel wires; the correction in Table XXXV. corresponding to this angle, is to be subtracted from the observed angular distance of the objects; thus if the distance between the wires was 3° , one of them would be elevated above the plane $1^{\circ} 30'$, and the other depressed as much below it; and if in taking an observation, the point of contact was estimated to be one-third part of the distance from the middle towards either wire, the angle of elevation or depression would be one-third part of $1^{\circ} 30'$ or $30'$; and if the observed distance was 100° , the correction in Table XXXV. would be $19''$, subtractive from the observed angle, which would therefore be $100^{\circ} - 19'' = 99^{\circ} 59' 41''$. In general it will not be necessary to attend to this correction.

To measure the distance between the Sun and Moon.

Screw on the telescope, and place the wires parallel to the plane of the instrument; then if the index glass is half silvered and half blacked, and the sun very bright, raise the plate before the silvered part of the glass, and with the screw L raise the telescope to the transparent part of the horizon glass; turn down one or more of the dark glasses according to the brightness of the sun; then hold the sextant so that its plane may pass through the sun and moon; if the sun be to the right hand of the moon, the sextant is to be held with its face upwards; if to the left hand, the face is to be held downwards: with the instrument in this position, look directly at the moon through the telescope, and move the index forward till the sun's image is brought nearly into contact with the moon's nearest limb; then fix the index by the screw under the sextant, and make the contact perfect by means of the tangent screw; at the same time move the sextant slowly, making the axis of the telescope the centre of motion, by which means the objects will pass each other, and the contact be more accurately made, observing that the point of contact of the limbs must always be observed in the middle between the parallel wires. The observation being thus made, the index will point out the distance of the nearest limbs of the sun and moon.

To measure the distance between the Moon and a Star.

Turn down the green screen if the moon is bright, and direct the plane of the instrument through both objects, with its face upwards, if the moon is to the right of the star; but if to the left, the face is to be held downwards; look at the star through the telescope and transparent part of the horizon glass, and move the index till the moon's image appears nearly in contact with the star: fasten the index, move the sextant round the axis of the telescope as in measuring the distance of the sun and moon, and turn the tangent screw, till the coincidence of the star and the enlightened or round limb of the moon is perfect; observing that the point of contact of the limb of the moon and star must always be in the middle between the parallel wires. The observation being thus made, the index will point out the distance of the enlightened limb of the moon from the star, whether it be the farthest or nearest limb.

If the observer suspect that the mirrors, or coloured glasses, have not their surfaces exactly parallel, he may verify them as follows:—

Verification of the parallelism of the Index glass.

This verification is to be made ashore, by observing the angular distance of two well defined objects, whose distance exceeds 90° or 100° (having previously well adjusted the instrument) then taking out the central mirror and turning it, so that the edge which was formerly uppermost may now be nearest the plane of the instrument; rectify its position and again measure the distance of the two objects; half the difference between these two distances will be the error of the observed angle arising from the defect of pa-

parallelism of the central mirror. If the first distance exceeds the second, the error is subtractive, otherwise additive, the mirror being in its first position; but the contrary when in its second position. Thus, if the first distance was $119^{\circ} 59' 21''$ and the second $120^{\circ} 0' 39''$, the error would be $39''$, additive when the mirror was in its first position, subtractive for the second. The error for any other angle may be found by means of col. 2d. Table XXXIV. when the inclination of the plane of the horizon glass to the axis of the telescope is 80° , by saying, as the tabular correction corresponding to 120° ($=4' 5''$) is to the error of the glass $39''$, so is the tabular error for any other angle as 85° ($=1' 15''$) to the corresponding error of the glass $12''$. In this manner a table of errors may be made for all angles.*

The angle between the plane of the horizon glass and axis of the telescope produced, being constant in all observations and adjustments of the sextant, no error can arise from the want of parallelism of its surfaces.

Verification of the parallelism of the surfaces of the coloured glasses.

Turn down the glass at D, which is to be examined, and another at E, to defend the eye from the sun; direct the telescope to the sun and move the index till its direct and reflected images coincide; then turn the dark glass at D, so that the surface which was farthest from the horizon glass may now be nearest to it, and if the contact of the same two limbs be complete, the surfaces of this glass are parallel, but if they lap over, or separate, the index must be moved to bring them again in contact, then half the arch passed over by the index will be the error, arising from the want of parallelism of the glass at D.



DESCRIPTION AND USES

OF THE

CIRCLE OF REFLECTION.

THE Circle of Reflection was invented by the celebrated professor MAYER of Groningen, and has since been greatly improved by the CHEVALIER DE BORDA, MR. TROUGHTON, and MR. MENDOZA Y RIOS. In its present improved state it has a decided superiority over the sextant in measuring the distance of the moon from the sun, or a star, on account of its correcting, in a great measure, the errors arising from a faulty division of the limb, want of parallelism in the surfaces of the mirrors and coloured glasses, and entirely avoiding the error which might arise in a sextant from the mirrors not being parallel when the index is on 0.

Fig. 1. Plate VIII. represents the Circle of Reflection, as given by DE BORDA; in fig. 2 is a section of the same instrument, marked with the same letters of reference as in fig. 1. The principal parts of this instrument are, the circular limb LMV; the central index EF; the horizon index MD; the central glass or mirror A; the horizon glass or mirror B; the telescope GH; the coloured glasses fig. 3, 4; the handle fig. 5; the ventelle fig. 6; and the adjusting tool fig. 7.

The limb of the instrument LMV, is a complete circle of metal, and is connected with a perforated central plate by six radii; it is divided into 720° because of the double reflection; each degree is generally divided into three equal parts, and the division is carried to minutes, or lower, by means of the verniers of the two indices.

The two indices are moveable round the same axis, which passes exactly through the centre of the instrument; the central index EF carries the cen-

* The method of calculating the above tabular numbers when the angle of inclination of the telescope and horizon glass differs from 80° is given in the explanation of Table XXXIV. prefixed to the tables.

tral mirror A; and the horizon index MD carries the telescope GH and the horizon mirror B; both indices are furnished with verniers and tangent screws at O and N.

The *central mirror* A is placed on the central index immediately above the centre of the instrument; the plane of this mirror makes an angle of about 50° with the middle line of the index, and is adjusted perpendicular to the plane of the instrument, by means of the screws placed on the back part of the frame of the mirror.

The *horizon glass* B is placed on the horizon index near the limb, so as to interfere as little as possible with the rays proceeding from objects situated on the opposite side of that index with respect to the central mirror. The horizon glass is adjusted perpendicular to the plane of the instrument in a similar manner to that of the horizon glass of a sextant: and in some circles this mirror is moveable about an axis perpendicular to the plane of the instrument, by which means the situation with respect to the telescope may be adjusted.

The *telescope* GH, attached to the other end of the horizon index, is an astronomical one inverting the observed objects, and has two parallel wires in the common focus of the glasses, distant from each other between two and three degrees. These wires, at the time of observation, must be placed parallel to the plane of the instrument: To effect this, marks are made on the eye-piece, and on the tube at G, and by making them coincide, the wires may be brought to their proper position. The telescope may be raised or depressed by two screws I, K, so as to be directed to any part of the horizon glass; and, by means of the graduations on the two standards *i*, *k*, the telescope may be rendered parallel to the plane of the instrument.

There are two sets of *coloured glasses* (fig. 3, 4) each set usually containing four glasses of different shades; the glasses of the larger set (fig. 4) which are placed before the central mirror at *a*, *a*, should have each about half the degree of shade with which the corresponding glasses (fig. 3) of the other set, placed at C, are tinged, because the rays from the luminous object pass twice through the coloured glass placed before the central mirror, and only once through the other. The glasses placed at *a*, *a*, are kept tight in their places by small pressing screws at their ends, or by slides passing in front, through perforations in the stems of their frames: when fixed for observation they make an angle of about 35° with the plane of the instrument, by which means the image from the coloured glass is not reflected to the telescope. When the angle to be measured is between 5° and 35° , one of the largest set is to be fixed at *a*, *a*; in other cases, one of the smaller set is to be placed in the socket C. The reason of using the large glass is this—when the small glass is placed at C, it intercepts the direct light of the luminous object in its passage towards the central mirror, if the object happens to be situated within the angular space, included by the lines from the centre A, by the sides of the frame of the glass placed at C. This is avoided by using the larger glasses.

The *handle* (fig. 5) is of wood, and is fixed to the back of the instrument immediately under the centre. By this it is held during the time of observation.

The *ventelle* (fig. 6.) is used in terrestrial observations to diminish the light of the object seen directly, to render it equal in brightness to that of the objects seen by reflection: this is performed by putting the ventelle in the socket D, and raising or depressing it till the objects appear of equal brightness.

There are two *adjusting tools* of the form represented in fig. 7; they are exactly of the same size, and their height is nearly equal to that of the central mirror; they may be used in adjusting the central mirror perpendicular to the plane of the instrument, and in making the axis of the telescope parallel to that plane.

The instrument, as we have now described it, is the same as it was left by De Burda; Mr. Troughton has since suggested the improvement of fixing to the horizon index the arch WSPR, and providing it with two sliding pieces U, X, in order to facilitate the fixing the indices at their proper

angles with each other in taking successive observations. When the central and horizon glasses are parallel, the central index covers the space SP of the arch, and the spaces SW, PR, are each divided into degrees from S to W, and from P to R, and numbered 0 at S and P, and continued to 150° towards W and R. The use of this arch and sliding pieces will be explained hereafter.*

That ingenious mathematician and navigator, M. Mendoza y Rios, has further improved the circular instrument by the substitution of a circular ring (moving round the centre of the instrument over or adjacent to the limb TMV) for a vernier instead of those attached to the indices by De Borda: and by fixing this circular vernier alternately to each of the indices it serves as a vernier for both, and after any number of observations, gives the compound motion of both indices, and thus double the number of distances are obtained by this instrument that can be obtained by De Borda's circle with the same number of observations. Mr. Rios has also improved the form of the handle for holding the instrument. In theory the instrument, as improved by Mr. Rios, appears to be superior to that of De Borda, but not having used one of the former kind, I cannot, from my own experience, decide whether it is so much superior in practice; but Mr. Rios says that he found it answered his expectations. As the method of taking the observation is nearly the same with both instruments, I shall confine myself to the explanation of the uses of De Borda's, from which the method of using the other will be easily discovered.

Adjustments of the Circle of Reflection.

Before entering upon an explanation of the adjustments of this instrument, it will be proper to premise that there are three different methods of observing the angular distance of two objects with this instrument, viz. (1) by what is called an observation to the right, (2) by an observation to the left, and (3) by a cross observation.

An observation to the right is that, where the object, whose image is to be reflected and the central mirror are on the same side of the telescope. *An observation to the left*, when the object to be reflected and the central mirror are on opposite sides of the telescope, which in both cases is supposed to be directed to the other object; and a *cross observation* is a combination of the fore-mentioned observations; the first being generally taken to the left, and the second to the right.

The adjustments of a circle consist in placing the mirrors perpendicular to the plane of the instrument, and in making the axis of the telescope parallel to that plane. These are all the adjustments necessary in measuring an angular distance by cross observations; but if one observation only be taken to the right, or to the left, it will be necessary to find the division, on which the horizon index must be placed, to make the horizon glass parallel to the central glass, when the central index stands on 0. These adjustments are similar to those of a sextant, but a particular explanation of each will here be given.

To set the central glass perpendicular to the plane of the instrument.

This adjustment may be made by placing the eye in front of the central glass at L, a little above the plane of the instrument, and observing if the reflected image of that part of the limb nearest the eye appears to make one continued circular line with the parts of the limb towards T, seen to the

* Mr. Troughton suggested another alteration in the circle, but (as Mr. Rios justly observes) the instrument thus altered may be considered as a sextant, the limb of which is completed to the whole circumference. A circle of this description is usually furnished with three indices and verniers, by each of which every observation must be read off. This is very troublesome, particularly in the night. It is true that this method corrects in a very great degree the error of not having the index fixed exactly on the centre, or that of not having an instrument perfectly circular; but errors of this kind in Borda's circle may be reduced in any ratio by taking a number of observations, and the error will in general be extremely small in taking a sufficient number to bring the index nearly to the point set out from; so that in those important points I should, on the whole, prefer an instrument of Borda's construction.

right and left of the central glass; for in this case the glass is perpendicular to the plane of the instrument; otherwise it must be adjusted by means of the screws till the two images coincide.*

By examining this adjustment in different parts of the limb, it will be known if the limb be in the same plane. If any difference should be found, the central glass must be so fixed that the reflected image of the limb may appear as much above the direct image in some places as below it in others.

To set the horizon glass perpendicular to the plane of the instrument.

The central glass being previously adjusted, and the telescope directed to the line separating the silvered from the transparent part of the horizon glass, hold the instrument nearly vertical, and move either index till the direct and reflected image of the horizon, seen through the telescope, coincide; then incline the instrument till it is nearly horizontal, and if the images do not separate, the horizon glass is perpendicular to the plane of the instrument; but if they do separate, the position of the glass must be rectified by means of the screws in its pedestal.

This adjustment may be also made by directing the sight through the telescope to any well defined object; then, if by moving the central index, the reflected image passes exactly over the object seen directly, the glass is perpendicular, otherwise its position must be adjusted by means of the screws attached to the pedestal of the glass.

A planet, or star of the first magnitude, will be a good object for this purpose. If the sun is used, one of the coloured glasses must be placed at C and another at D.

To make the axis of the telescope parallel to the plane of the instrument.

The telescope may be raised or depressed by means of two screws attached to the standards *i*, *k*, (fig. 2) and passing through two pieces of brass connected with the tube of the telescope. On each of these pieces is a mark or index by which the telescope is to be adjusted, for, by bringing the indices to the same mark on each standard, the telescope will be parallel to the plane of the instrument.†

To find that division to which the horizon index must be placed to render the mirrors parallel when the central index is on 0.

Place the central index on 0; direct the telescope to the horizon glass, so that the line joining the silvered and transparent parts of that glass may appear in the middle of the telescope; hold the instrument vertically, and move the horizon index, till the direct and reflected horizons agree, and the division shown by the horizon index will be that required.

This adjustment may also be made by measuring the diameter of the sun in contrary directions; thus, the central index being fixed on 0, place a dark glass at C and another at D; direct the telescope (through the transparent part of the horizon glass) to the sun, and move the horizon index, till his reflected image appear in the telescope; bring the upper edge of the direct image to coincide with the lower of the other, and note the angle shown by the index; then, by moving the horizon index, bring the lower edge of the

* When the instrument is furnished with adjusting tools, this adjustment may be made in the following manner. Set the two tools on opposite parts of the limb at T and L; place the eye at *e*, at nearly the same height as the upper edge of the tools, so that part of the tool at T may be hid by the central glass; move the central index till the reflected image of the tool nearest the eye appears in the central glass at the side of the other tool seen directly; then if the upper edges of the tools are apparently in the same straight line, the central glass is perpendicular to the plane of the instrument, otherwise its position must be adjusted by the screws at the back of the frame.

† If you suspect that the marks on the standards are inaccurate, you may examine them in the following manner. Lay the circle horizontally on a table; place the two adjusting tools on opposite parts of the limb at T and L; and at about 12 or 15 feet distance let a well defined mark be placed, so as to be in the same straight line with the tops of the tools; then raise or lower the telescope till the mark is apparently in the middle between the two wires; then the axis of the telescope will be parallel to the plane of the instrument, and the difference (if any) between the divisions pointed out by the indices on the graduation of the standards *i*, *k*, (fig. 2) will be the error of the indices, by knowing which, it will be easy in future adjustments to make allowance for the error.

direct image to coincide with the upper edge of the reflected one, and note also the angle pointed out by the index; half the sum of these two angles will be the point of the limb where the horizon index must be placed to render the mirrors parallel. Thus, if the index in the first observation stood on $473^{\circ} 30'$, and in the second on $474^{\circ} 34'$, the half sum of the two $474^{\circ} 2'$ would be the point where the horizon index must be placed to make the mirrors parallel.

These are all the adjustments necessary to be made preparatory to measuring any angular distance.* When the angle is measured by cross observations, the error arising from the want of parallelism of the surfaces of the mirrors, and screens, will in general be very small; however, the method of verifying those glasses and making allowance for any error in them will be given hereafter.

To observe the meridian altitude of any celestial object, either by an observation to the right or to the left.

The method of observing the meridian altitude of an object with a circle is exactly similar to that with a quadrant or sextant. The central index must be fixed on 0, and the horizon index on the point which renders the two mirrors parallel; then the altitude may be taken either by an observation to the right or to the left; but the former method, in which the large coloured glasses are not necessary, is in general to be preferred; because those large glasses are more liable to cause an error in the observation than the small ones.

If an observation to the right is to be taken, a small dark glass must be placed at C, if the object be bright, then hold the instrument in the right hand in a vertical position; move the central index, according to the order of the divisions of the limb, till the reflected image of the object, seen in the telescope, nearly touches the direct image of the horizon; tighten the index by the screw at the back of the instrument; make the contact complete in the middle between the parallel wires of the telescope, by the tangent screw, and by sweeping, exactly in the same manner, as when observing with a quadrant, and the central index will point out the altitude of the object.

If an observation to the left is taken, and the object be bright, a large dark glass must be placed at *a a*, if the altitude be between 5° and 35° ; otherwise a small glass at C; hold the instrument in the left hand, in a vertical position, move the central index contrary to the order of the divisions, and bring the reflected image in contact with the horizon as above: the angle shown by the central index being subtracted from 720° , will be the sought altitude.

In both these methods of observing the meridian altitude of an object, the circle, the radius of which is only five inches, will hardly be so accurate as a good sextant of a larger radius; but, by the help of a well regulated watch, the meridian altitude may be obtained, by the circle, to a much greater degree of accuracy than by a sextant, by observing in the following manner. A few minutes before the object passes the meridian, begin to observe the altitude by cross observations (in the manner to be described in the next article) and note the time of each observation by the watch: continue to observe till a few minutes after the object has passed the meridian: then the angles shown by the central index being divided by the whole number of observations, will give the approximate meridian altitude; the correction to be applied to it to obtain the true meridian altitude, may be found by means

* In some instruments there is an adjustment of the horizon glass, to place it at its proper angle with the axis of the telescope; if an adjustment of this kind is necessary, it ought to be made before the other adjustments, in such manner, that if a coloured glass be fixed at C, none of the rays from the central glass can be reflected to the telescope from the horizon glass without passing the coloured glass. To effect this, the *ventelle* must be placed at D, and lowered so as to intercept the direct light entirely; then place the coloured glass at C, and direct the telescope to the silvered part of the horizon glass; move the central index, and if no uncoloured images appear (reflected from the central glass) but all have the same tinge as that of the coloured glass used, the horizon glass is in its proper position; otherwise it must be turned on its axis till the uncoloured images disappear.

Tables XXXII. and XXXIII. by a method which will be explained hereafter, when treating of finding the latitude by a single altitude of the sun.

In this article the meridian altitude has only been spoken of, though it is evident that the method is applicable to an object not on the meridian; but in this case the cross observations, which give to the circle all its advantages, may be used, and the mean of the altitudes taken instead of a single altitude: this method is peculiarly adapted to the taking of altitudes for regulating a watch, for which reason it will be particularly explained in the following article:—

To take altitudes of the sun or any celestial object, by cross observations, for regulating a watch.

Fix the central index on 0, and if the object be bright and the altitude between 5° and 35° place a large coloured glass before the central glass, at a or c ; otherwise a small one at C ; hold the instrument in the left hand, in a vertical position: move the horizon index till the image of the reflected object be brought in complete contact with the horizon, in the middle between the two parallel wires of the telescope, as directed in the preceding article, and note the time of observation by the watch; then fasten the horizon index: hold the instrument in the right hand, in a vertical position, move the central index according to the order of the divisions, till the reflected image be again brought into complete contact with the horizon* as above, and note the time of observation. Then half the sum of the times, and half the angle shown by the index, will be a mean time, and a mean altitude corresponding thereto.

Times of obs.		Angle.
4h. 20.	0.	
4.	21. 10.	6) 60° 24'
4.	22. 15.	
4.	23. 0.	
4.	24. 45.	
4.	25. 30.	
6)	26. 16. 40.	10. 4.
	4. 22. 47.	

If greater accuracy be required, the observation must be repeated, setting out from the points where the indices then are, and observing in the same manner by moving first the horizon index, then the central one: continue taking as many of these cross observations as are judged necessary, and note the times of each observation: Then the sum of the times, divided by the whole number of observations, will be a mean time; and the angle shown by the central index, divided by the number of observations, will be a mean altitude corresponding thereto. Thus, if six observations were taken, and the times noted as in the adjoined table, the angle shown by the index being $60^{\circ} 24'$, the mean time would be obtained by dividing the sum of the times 26h. 16' 40" by 6, and the mean altitude by dividing $60^{\circ} 24'$ by 6; therefore the mean time would be 4h. 22' 47" and the mean altitude corresponding $10^{\circ} 4'$.

To measure the distance between the sun and moon, by a circular instrument.

The instrument being well adjusted, fix the central index on 0, and if the object be bright, place a small dark glass at C ; hold the instrument so that its plane may be directed to the objects, with its face downwards when the sun is to the right of the moon: otherwise, with its face upwards: direct the sight through the telescope to the moon; move the horizon index according to the order of the divisions of the limb, till the reflected image of the sun appears in the telescope, and the nearest limbs of the sun and moon are almost in contact; fasten the index, and make the coincidence of the

* The arch described on the limb by the central index will be equal to twice the altitude of the object, or twice the angle passed over by the other index: if more cross observations be taken, each of the indices, when moved, will describe an arch equal to double the altitude of the object: the same is to be observed in measuring any other angular distance. If the instrument is furnished with the arch WSR, and sliding pieces U, X, you must bring the slide X to the central index after taking the first observation: to the left, and place the slide U at the same degree on the arch SW that X is on the arch PR: then, in the next observation, the central index is to be brought to touch the slide U: in the next observation to the left the slide X is to be brought to the central index, and so on for the other observations. Thus, by means of the slides, the indices may be placed at nearly their proper angles with each other at the beginning of the observation, which will save considerable time. After being thus fixed, the contact must be completed by means of the tangent screw of the index, which is to be moved.

limbs perfect, in the middle between the two parallel wires of the telescope, by means of the tangent screw of the horizon glass, and note the time of observation, then invert the instrument, and move the central index, according to the order of the divisions of the limb, by a quantity equal to twice the arch passed over by the horizon index (or twice the distance of the sun and moon;*) direct the plane of the instrument to the objects; look directly at the moon, and the sun will be seen in the field of the telescope: fasten the central index, and make the contact of their nearest limbs complete, in the middle between the two parallel wires of the telescope, by means of the tangent screw of the central index, and note the time of observation; then half the arch shown by the central index will be the distance of the nearest limbs of the sun and moon, and half the sum of the times will be the mean time of observation.

Having finished these two observations, two others may be taken in the same manner, setting out from the points where the indices then are, and moving first the horizon index, then the central index: proceed thus, till as many observations as are judged necessary be taken, always observing that the number of them be even; then the angles shown by the central index (or that angle increased by 720° , or 1440° , &c. if the index has been moved once or twice, &c. round the limb) being divided by the whole number of observations, will give the mean distance, and the sum of all the times divided in like manner will be the mean time of observation.

To measure the distance between the moon and star, by a circular instrument.

Fix the central index on 0, and if the moon be bright, and the distance between 5° and 35° , place a large green glass before the central mirror at *a a*, otherwise a small one at *C*; hold the instrument so that its plane may be directed to the objects, with its face downwards when the moon is to the right of the star, otherwise with its face upwards; direct the sight through the telescope to the star; move the horizon index, according to the order of the divisions of the limb, till the reflected image of the moon appears in the telescope, and the enlightened limb of the moon be nearly in contact with the star; fasten the index, and make the coincidence perfect, in the middle between the parallel wires of the telescope, by means of the tangent screw belonging to that index, and note the time of observation; then invert the instrument, and move the central index, according to the order of the divisions of the limb, by a quantity equal to twice the arch passed over by the horizon index;* direct the plane of the instrument to the objects, look directly at the star, and the moon will be seen in the field of the telescope: fasten the central index, and make the contact of the enlightened limb of the moon and the star complete, in the middle between the two parallel wires of the telescope, by means of the tangent screw of that index, and note the time; then half the arch shown by the central index will be the distance of the star from the enlightened limb of the moon, and half the sum of the times will be the mean time of observation; these two observations being completed, others may be taken in the same manner, according to the directions above given for measuring the distance of the sun from the moon.

In continuing to take these cross observations by a circle furnished with the arch WSR, and slides U, X, it will be very easy to bring the reflected image into the field of the telescope; but if the instrument is not thus furnished, it will be often difficult to bring the image into the field of the telescope, and much time will be lost, and the observations rendered tedious by that means; to remedy this, a small table of the angles at which each index should be placed, ought to be made before beginning the observation: this table is easily formed, as follows: find roughly according to the directions heretofore given, the point at which the horizon glass must be placed to be parallel to the central glass, when the central index is on 0; then find what point of the arch the horizon index stands upon after measuring the first distance, as directed above; the difference between these

* This may be done expeditiously by means of the slides U, X, as was explained in the preceding way.

two points will be the angular distance of the objects; the double of this distance being successively added to 0° , and to the angle pointed out by the horizon index after the first observation, will give the points of the arch where the indices must be placed at the 2d. 3d. 4th. &c. observations. Thus, if the point of parallelism was 471° and the point where the horizon index was at the first observation, was 525° , the difference or 54° would be the angular distance; the double of which, or 108° , being added to 525° gives 633° , which is the point of the arch where that index must be placed at the third observation; 633° added to 108° gives 741° or 21° (because the divisions recommence at 720°) which is the point where the index must be placed at the fifth observation, &c. as in the adjoined Table. The central index being at first on 0° , after the second observation it will be on 108° , at the fourth on $108^\circ + 108^\circ = 216^\circ$, at the sixth on $216^\circ + 108^\circ = 324^\circ$, &c. Thus, by constantly adding 108° , or twice the distance of the objects, the angles, at which the indices must be placed, will be obtained; and by fixing them at these angles, the reflected image will be brought into the field of view without any trouble.*

Central Index	Horizon Index
0°	525
108	633
216	21
324	129
432	237
540	&c.
&c.	

Having explained the methods of adjusting and using the circle of reflection, it remains to show how to calculate the error arising from not observing the contact of the objects in the middle between the parallel wires of the telescope, and also to estimate the errors arising from the want of parallelism of the mirrors and coloured glasses. These verifications are much more necessary in a sextant than in a circle, and they may be in general neglected.

To estimate the error arising from not observing the contact of the objects in the middle between the parallel wires of the telescope.

To estimate that error, it is necessary to know the angular distance of the wires of the telescope, which may be thus determined.

Turn round the eye-piece of the telescope, till the wires are perpendicular to the plane of the instrument, and put the central index on 0; direct the telescope to any well defined object, at least 12 feet distant, and move the horizon index till the direct and reflected image of the object coincide; then make one of the wires coincide with the object, and turn the central index till the reflected image of the object coincides with the other wire—and the arch passed over by that index will be the angular distance between the wires. This angle being obtained, the observer must, by means of it, estimate, at each observation, how much the place where the contact was observed was elevated above, or depressed below the plane passing through the eye and the middle line between the two parallel wires of the telescope: the correction in Table XXXV. corresponding to this angle, is to be subtracted from the observed angular distance of the objects: thus if the distance between the wires was 2° , one of them would be elevated above that plane 1° and the other depressed below it, by the same quantity; if, in taking an observation, the point of contact was estimated to be one-third part of the distance from the middle towards either wire, the angle of elevation or depression would be one-third part of 1° or $20'$; and if the observed distance was 120° the correction in Table XXXV. would be $12''$ subtractive from the observed distance.

The correction for each observed distance being ascertained, in the above manner, the sum of them must be subtracted from the whole angle shown

* If the distance of the object varies during the observation, these angles will require correction as you proceed with the observations. Thus if the distance was increasing, and at the sixth observation it was 7 and that the central index was on 326° instead of 324° , the increase being 2° , you must add 2 to the rest of the numbers in the Table, and place the horizon index at the seventh observation on $129 + 2 = 131^\circ$ and the central index at the eighth observation at $432 + 2 = 434^\circ$, &c.

by the central index, and the remainder, divided by the whole number observations, will be the mean distance.

Verification of the parallelism of the surfaces of the central mirror.

This verification is to be made ashore, by observing the angular distance of two well defined objects, whose distance exceeds 90° or 100° , having previously well adjusted the instrument; after taking several cross observations and finding the mean distance, take out the central mirror and turn it that the edge which was formerly uppermost may now be nearest the plane of the instrument; rectify its position, and take an equal number of cross observations of the angular distance of the same two objects; half the difference between the mean of these, and that of the former, will be the error of the observed angle, arising from the defect of parallelism of the central mirror. If the first mean exceeds the second, the error is subtractive, otherwise additive, the mirror being in its first position; but the contrary when in its second position. Thus, if 10 observations were taken at each operation, and in the first the angle shown by the index, was $119^{\circ} 53'$, and the second $120^{\circ} 6'$; by dividing by 10 the mean angles are found to be $119^{\circ} 59' 21''$ and $120^{\circ} 0' 39''$, the difference of which is $78''$, the half of which is $39''$ is the error of the mirror additive when it is in its first position, subtractive in the second. The error for any other angle may be found by consulting Table XXXIV. when the inclination of the plane of the horizon glass to the axis of the telescope is 18° , by saying, as the tabular error corresponding to 120° that is $1' 30''$ is to the error found in the glass $39''$ so is the tabular error for any other at 85° which is $0' 28''$, to the error of the glass corresponding $12''$; and in this manner a table of errors may be made, not only for the cross observations, but also for the observations to the right and left.*

It may be remarked that the errors are much less in the cross observations than in the observations to the right, which are those made with a quadrant or sextant, so that the circle has, in this respect, greatly the advantage over those instruments.

The angle between the plane of the horizon glass and axis of the telescope produced, being nearly the same in all observations and adjustments of the circle, no sensible error can arise from the want of parallelism in the surfaces of that glass.

Verification of the parallelism of the coloured glasses.

Place one of the dark coloured glasses at C and another at D, fix the central index at 0, direct the telescope to the sun, and move the horizon index till the limbs of the direct and reflected image coincide; then turn the dark glass placed at C, so that the surface which was farthest from the horizon glass may now be nearest to it, and if the contact of the same two limbs is complete, the surfaces of the glass placed at C are parallel: but if the limbs lap over or separate, the central index must be moved to bring them again in contact, then half the arch passed over by that index will be the error arising from the want of parallelism of the glass C. If great accuracy is required the operation may be repeated, by setting out from the point where the indices then are, and taking 4 or 6, &c. observations, then the arch passed over by the central index being divided by 4, 6, &c. will be the sought error. The other small glasses may be verified in the same manner; and by placing one of the larger glasses before the central index at *a a*, and one of the smaller ones at D, the former may be verified as above. The green glass may be verified by observing the diameter of the full moon, or by some bright terrestrial object.

It may be remarked as one of the greatest advantages of the circle, that in measuring an angle by the cross observations, no error can arise from the

* If the inclination of the plane of the horizon glass and the axis of the telescope differ from 80° , you may find the tabular numbers by the method given in the explanation of Table XXXIV. prefixed to the Tables.



Fig. VII.

Fig. 1.

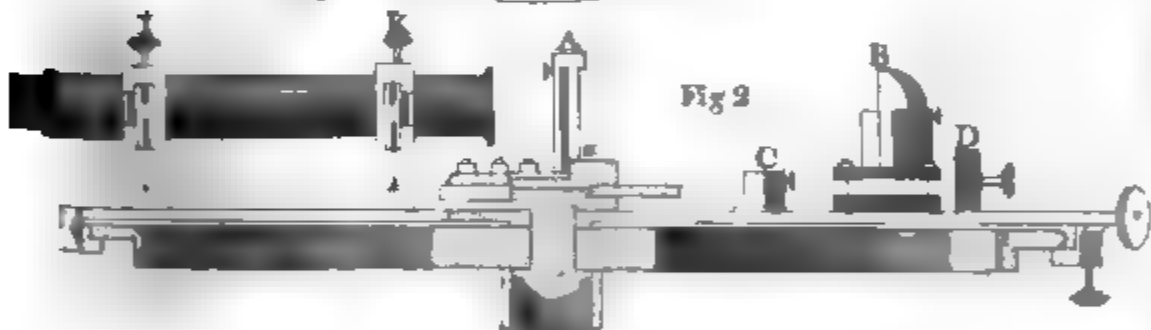
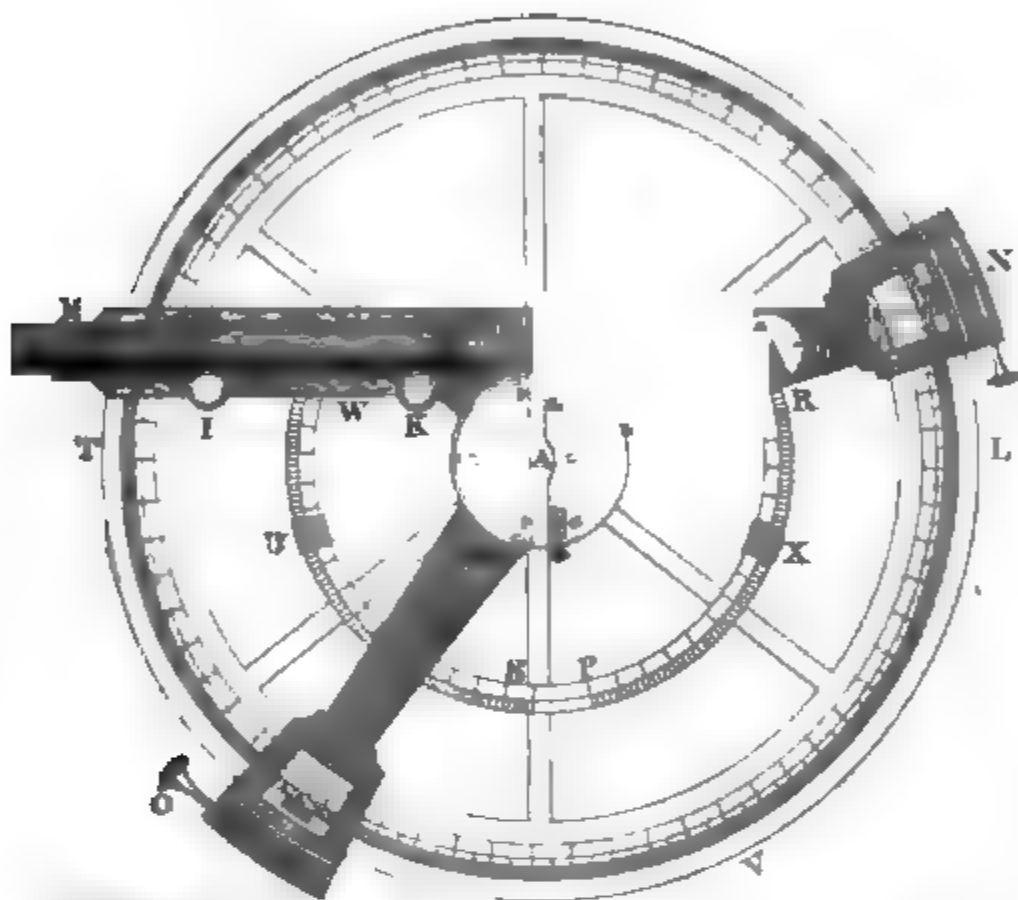


Fig. 2.

Fig. 5.



Fig. 3.



Fig. 4.



Fig. 6.



Fig. 7.



want of parallelism in the surfaces of the smaller dark glasses; for if those glasses give too great an angle by an observation to the right, they give too little by the same quantity by an observation to the left. It is not so with the larger glasses placed at a , because the incidence of the rays on those glasses is more oblique in one observation than in the other, so that the errors do not wholly balance each other; however, as those glasses are used only in measuring angles less than 35° , in which the errors are nearly the same as if the incidence of the rays was perpendicular, the errors of those glasses will also nearly compensate each other in the cross observations; and if those observations only were used, it would be unnecessary to verify the dark glasses:—Even when taking observations to the right, or observations to the left, the error of the dark glasses would be destroyed, if the glass was turned at each observation, and the number of observations was even; but there are some cases in which an angle can only be measured by one observation, then it would be necessary to allow for the error of the dark glass, if the distance was required to be found within a few seconds.



ON PARALLAX, REFRACTION,

AND

DIP OF THE HORIZON.

PARALLAX (or diurnal parallax) is the difference between the true altitude of the sun, moon, or star, if it were observed at the centre of the earth, and the apparent altitude observed at the same instant by a spectator at any point on the surface of the earth.

Thus in Plate IX. fig. 3, let ABC be the earth, C its centre, A the place of a spectator, EDF part of the moon's orbit, $e d G$ part of the orbit of a planet, and KZ part of the starry heavens. Then if at any time the moon be at D, she will be referred to the point H by a spectator supposed to be placed at the centre of the earth, and this is called the *true place* of the moon, but the spectator at A will refer the moon to the point b , and this is called the *apparent place* of the moon, the difference H b (or the angle $HDb = ADC$) is called the moon's *parallax in altitude*, which is evidently greatest when the moon is in the horizon at E, being then equal to the arch KI, and decreases from the horizon to the zenith and is there nothing. The parallax is less as the objects are farther from the earth: thus the parallax of a planet at d is represented by $a b$, being less than that of the moon at D; and the horizontal parallax K f of the planet is less than the horizontal parallax KI of the moon. As the parallax makes the objects appear lower than they really are, it is evident that the parallax must be added to the apparent altitude to obtain the true altitude. Having the horizontal parallax, the parallax in altitude is easily found by the following rule—*As radius is to the co-sine of the apparent altitude, so is the horizontal parallax to the parallax in altitude.* This rule may be easily proved: for in the triangle CAE we have $CE : CA :: \text{radius} : \sin CEA$; and in the triangle CDA we have CD (or CE) : $CA :: \sin CAD : \sin CDA$; hence we have, $\text{radius} : \sin CEA :: \sin CAD : \sin CDA$, but $CEA = \text{horizontal parallax}$, $CDA = \text{parallax in altitude}$, and $\sin CAD = \text{co-sine app. alt.}$. Hence we have $\text{radius} : \text{co-sine app. alt.} :: \sin \text{hor. par.} : \sin \text{par. in alt.}$ but the parallaxes of the heavenly bodies being very small, the sines are nearly proportional to the parallaxes, hence we may say, as $\text{radius} : \text{co-sine app. alt.} :: \text{hor. par.} : \text{par. in alt.}$

The sun's mean parallax in altitude is given in Table XIV. for each 5° or 10° of altitude. The moon's horizontal parallax is given in the 7th page of the month of the Nautical Almanac, for every noon and midnight at the meridian of Greenwich.

REFRACTION OF THE HEAVENLY BODIES.

It is known by various experiments that the rays of light deviate from their rectilinear course in passing obliquely out of one medium into another of a different density, and if the density of the latter medium continually increase, the rays of light in passing through it will deviate more and more from the right lines in which they were projected towards the perpendicular to the surface of the medium: This may be illustrated by the following experiment: make a mark at the bottom of any bason or other vessel, and place yourself in such a situation that the hither edge of the bason may just hide the mark from your sight, then keep your eye steady, and let another person fill the bason gently with water: as the bason is filled, you will perceive the mark come into view, and appear to be elevated above its former situation. In a similar manner, the light in passing from the heavenly bodies through the atmosphere of the earth deviates from its rectilinear course, by which means those objects appear higher than they really are, except when in the zenith; this apparent elevation of the heavenly bodies above their true places, is called the refraction of those bodies. To illustrate this, let ABC (Fig. 2, Plate IX.) represent the atmosphere surrounding the earth DEF, and let an observer be at D, and a star at α , then if there were no refraction, the observer would see the star according to the direction of the right line D α , but as the light is refracted, it will, when entering the atmosphere near A, be bent from its rectilinear course, and will describe a curve line from A to D, and at entering the eye of the observer at D will appear in the line D β , which is a tangent to the curve at the point D, and the arch $\alpha\beta$ will be the refraction in altitude or simply the refraction, which must be subtracted from the observed altitude to obtain the true.

At the zenith the refraction is nothing, and the lesser the altitude the more obliquely the rays will enter the atmosphere, and the greater will be the refraction: at the horizon the refraction is greatest. In consequence of the refraction, any heavenly body may be actually below the horizon, when appearing above it. Thus when the sun is at T below the horizon, a ray of light TI proceeding from T comes straight to I, and is there, on entering the atmosphere, turned out of its rectilinear course, and is so bent down towards the eye of the observer at D, that the sun appears in the direction of the refracted ray above the horizon at S.

The mean quantity of the refraction of the heavenly bodies is given in Table XII. All observed altitudes of the sun, moon, planets, or other heavenly bodies, must be decreased by the numbers taken from that Table corresponding to the observed altitude of the object. The refraction varies with the temperature and density of the air, increasing by cold or greater density, and decreasing by heat and rarity of the atmosphere. The corrections to be applied to the numbers taken from Table XII. for different heights of Fahrenheit's Thermometer and the Barometer, are given in Table XXXVI.* Thus, if the refraction was required for the apparent altitude 5° , when the thermometer was at 20° and the barometer at 30.67 inches, we should have the mean refraction by Table XII. equal to $9' 53''$, and by Table XXXVI. the correction corresponding to the height of the thermometer 20° equal to $+48''$, and for the barometer 30.67 equal to $+22''$, hence the true refraction will be $9' 53'' + 48'' + 22'' = 11' 3''$.

There is sometimes an irregular refraction near the horizon caused by the vapours near the surface of the earth; the only method of avoiding the error arising from this source, which is sometimes very great, is to take the observations at a time when the object which is observed is more than 10° above the horizon.

The refraction makes any terrestrial object appear more elevated than it really is; the quantity of this elevation varies at different times from $\frac{1}{4}$ to $\frac{1}{2}$

* This table is to be entered with the height of the Thermometer or Barometer at the top, and the apparent altitude at the side, under the former, and opposite the latter, will be the correction corresponding to the Thermometer or Barometer, which is to be applied to the mean refraction by addition or subtraction according to the signs at the top of the columns respectively.

of the angle formed at the centre of the earth, between the object and the observer, but in general this refraction is about $\frac{1}{4}$ of that angle.

DIP OF THE HORIZON.

Dip of the horizon is the angle of depression of the visible horizon below the true or sensible horizon (touching the earth at the observer) arising from the elevation of the eye of the observer above the level of the sea. Thus in Plate IX. Fig. 1. let ABC represent a section of the earth, whose plane produced passes through the observer and the object, and let AE be the height of the eye of the observer above the surface of the earth, then FEG drawn parallel to the tangent to the surface at A, will represent the true horizon, and EIH, touching the earth at I, will represent the apparent horizon;—therefore the angle FEH will be the dip of the horizon. Let M be an object whose altitude is to be observed by a fore observation by bringing the image in contact with the apparent horizon at H; then will the angle MEH be the observed altitude, which is greater than the angle MEF (the altitude independent of the dip) by the quantity of the angle FEH; so that in taking a fore observation the dip must be subtracted from the observed altitude to obtain the altitude corrected for the dip. In a back observation the apparent horizon is in the direction EK, and by continuing this line in the direction EL we shall have the observed altitude MEL, and it is evident that to this the dip LEF (=KEG) must be added to obtain the altitude corrected for the dip.

In Table XIII. is given the dip for every probable height of the observer expressed in feet. In calculating this table, attention was paid to the terrestrial refraction which decreases the dip a little, because IE becomes a curve line instead of a straight one, and EH is a tangent to that curve in the point E.

What has been said concerning the dip of the horizon supposes it free from all incumbrances of land or other objects; but as it often happens when ships are sailing along shore, or are at anchor in a harbour, that an observation is wanted when the sun is over the land, and the shore nearer the ship than the visible horizon would be if it were unconfined; in this case the dip of the horizon will be different from what it otherwise would have been, and greater the nearer the ship is to that part of the shore to which the sun is brought down. For this reason Table XVI. has been inserted, which contains the dip of the sea at different heights of the eye, and at different distances of the ship from the land. This table is to be entered at the top with the height of the eye of the observer above the level of the sea in feet, and in the left hand side column with the distance of the ship from the land in sea miles and parts; under the former, and opposite the latter, stands the dip of the horizon, which is to be subtracted from the altitude observed by a fore observation instead of the numbers in Table XIII.

The distance of the land requisite in finding the dip from Table XVI. may be found nearly in the following manner—Let two observers, one placed as high on the main-mast as he can conveniently be, and the other on the deck immediately beneath him, observe at the same instant the altitude of the sun or other object that may be wanted, and let the height of the eye of the upper observer above that of the lower be measured in feet and multiplied by 0.56, and the product, divided by the difference of the observed altitudes of the sun in minutes, will be the distance in sea miles, nearly.

Thus, if the eye of the upper observer was 68 feet higher than that of the lower, and the two observed altitudes of the sun $20^{\circ} 0'$ and $20^{\circ} 12'$ the distance of the land in sea miles would be 3.2. For $68 \times 0.56 = 38.08$ and this divided by the difference of the two observed altitudes of the sun $12'$ gives 3.2 nearly. Now if the lower observer was 25 feet above the level of the sea, the dip corresponding to this height and the distance 3.2 miles would be $6'$, which subtracted from $20^{\circ} 0'$ leaves $19^{\circ} 54'$ the altitude corrected for the dip.

The dip may be calculated in this kind of observations to a sufficient degree of accuracy without using Table XVI. in the following manner—Divide

the difference of the heights of the two observers in feet by the difference of the observed altitude in minutes, and reserve the quotient. Divide the height of the lower observer in feet by this reserved number, and to the quotient add one quarter of the reserved number, and the sum will be the dip in minutes corresponding to the lower observer. Thus in the above example $\frac{6\frac{3}{4}}{1\frac{1}{2}} = 5'.6$ is the reserved number, and $\frac{2\frac{1}{2}}{5.6} = 4.4$, to this add one fourth of 5'.6 or 1'.4 and the sum will be the dip 5'.8 or nearly 6' corresponding to the lower observer, being the same as was found by the table.



TO FIND THE SUN'S DECLINATION.

THE declination of the sun is given to the nearest minute in Tab. IV. for every noon at Greenwich, from the year 1824 to 1838; and this table will answer for some years beyond that period, without any material error; if great accuracy is required, the declination may be taken from the second page of the month of the Nautical Almanac.* This declination may be reduced to any other meridian, by means of Table V. in the following manner.

To find the sun's declination at noon, at any place.

RULE. Take out the declination at noon at Greenwich from Table IV. (or from the Nautical Almanac;) then find the longitude from Greenwich in the top column of Table V. and the day of the month in the side column; under the former, and opposite to the latter, will be a correction in minutes and seconds, to be applied to the declination taken from Table IV: to know whether this correction be additive or subtractive, you must look at the top of the column where you found the day of the month, and you will see it noted whether to add or subtract, according as the longitude is east or west. This correction being applied, you will have the declination at noon at the given place.

EXAMPLE I.

Required the declination of the sun at the end of the sea-day, October 10, 1824, in the longitude of 114° E. from Greenwich?

Sun's declination Oct. 10, at Greenwich, at the end of the sea-day	
or beginning of the day in the N. A. by Tab. IV.	$6^{\circ} 41' S.$
Variation of Dec. Tab. V. Oct. 10, in 114° E. long. sub.	$0 \quad 7$

True dec. noon, Oct. 10. in long. 114° E.	$6 \quad 37 \quad S.$
--	-----------------------

EXAMPLE II.

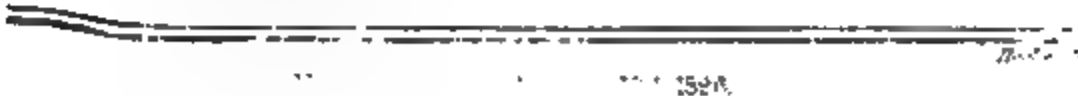
Required the sun's declination at noon ending the sea-day of March 12, 1824, in the longitude of 75° W. from Greenwich?

Sun's declination March 12, by Tab. IV.	$3^{\circ} 15' S.$
Var. Tab. V. March 12, long. 75° W. sub.	5

True declination, noon, March 12, long. 75° W.	$3 \quad 8 \quad S.$
---	----------------------

The preceding correction ought always to be applied to the declination used in working a meridian observation to determine the latitude, though many mariners are in the habit of neglecting it.

* In finding the declination, or any other quantity, in the Nautical Almanac, you must be careful to note the difference between the civil, nautical, and astronomical account of time. The civil day begins at midnight, and ends the following midnight, the interval being divided into 24 hours, and is reckoned in numeral succession from 1 to 12, then beginning again at 1 and ending at 12. The nautical or sea day begins at noon, 12 hours before the civil day, and ends the following noon; the first 12 hours are marked P. M. the latter A. M. The astronomical day begins at noon, 12 hours after the civil day, and 24 hours after the sea day, and is divided into 24 hours, numbered in numeral succession from 1 to 24, beginning at noon, and ending the following noon. All the calculations of the Nautical Almanac are adapted to astronomical time; the declination marked in the Nautical Almanac, or in Table IV, is adapted to the beginning of the astronomical day, or to the end of the sea-day, it being at the end of the sea-day when mariners want the declination to determine their latitude. It would be much better if mariners would adopt the astronomical day, and wholly neglect the old method of counting by the civil day.



TO FIND THE SUN'S DECLINATION.

111

To find the sun's declination at any time under any meridian.

RULE. Reduce the sun's declination at noon at Greenwich to noon under the given meridian, by the preceding rule. Then enter Table V. with the time from noon at the top, and the day of the month in the side column; under the former, and opposite the latter, will be the correction to be applied to that reduced declination. To know whether this correction be additive or subtractive, you must look at the top of the column where you found the day of the month, and you will find it noted whether to add or subtract, according as the time is before or after noon.

EXAMPLE III.

Required the sun's declination October 10, 1824, sea account, at 8h. 21' in the forenoon, in the longitude of 114° E. from Greenwich?

Sun's declination Oct. 10, at Greenwich at noon, by Tab. IV. $6^{\circ} 44' S.$
Variation for 114° E. long. sub. 7

Declination at noon, October 10, in long. 114° E. $6^{\circ} 37' S.$
Variation of dec. for 3h. 39' from noon* Oct. 10, . . . sub. 3

True dec. Oct. 10, sea acc. in long. 97° E. at 8h. 21' A. M. $6^{\circ} 34' S.$

EXAMPLE IV.

Required the sun's declination May 10, 1824, sea account, at 5h. 30' P. M. in the longitude of $17^{\circ} 30'$ E. from Greenwich?

Variation of declination, May 10, in long. $17^{\circ} 30'$ E. . . sub. 48"
Variation of declination for 5h. 30' P. M. additive $3' 44''$

Diff. is additive because the greatest number is so $2^{\circ} 58'$
May 10, sea account, is May 9, by N. A. at which time sun's declination $17^{\circ} 25' 10''$

True declination May 10, 5h. 30' P. M. sea account in long. $17^{\circ} 30'$ E. $17^{\circ} 28' 6'' N.$

EXAMPLE V.

Required the sun's declination March 26, 1824, sea account, at 3h. P. M. in the longitude of 120° E. from Greenwich?

Variation of declination, March 26, in long. 120° E. . . sub. $7' 50''$
Variation for 3h. P. M. add $2^{\circ} 56'$

Diff. is subtractive because the greatest number is so $0^{\circ} 451'$
March 26, sea acc. is Mar. 25, by N. A. at which time sun's dec. $1^{\circ} 54' 41'' N.$

True declination March 26, 3h. P. M. sea account $1^{\circ} 49' 47'' N.$



VARIATION OF THE COMPASS.

It was many years after the discovery of the compass, before it was suspected that the magnetic needle did not point accurately to the north pole of the world; but about the middle of the sixteenth century, observations were made in England and France, which fully proved that the needle pointed to the eastward of the true north. This difference is called the *variation of the compass*, and is named *east* when the north point of the compass (or magnetic north) is to the eastward of the true north; but *west* when the north point of the compass is to the westward of the true north. The quantity of the variation may be found by observing with a compass the bearing of any celestial object when in the horizon (or, as it is called, the *magnetic amplitude*) the difference between this and the true amplitude found by calculation, will be the variation. The same may be obtained by observ-

* In the present example, the time is Oct. 10, 8h. 21' A. M. which evidently wants 3h. 39' of the day of the sea day Oct 10, for which time the declination is marked in Table IV

ing the *magnetic azimuth* of any celestial object (that is, its bearing by a compass when elevated above the horizon;) the difference between this and the true azimuth found by calculation will be the variation.

Some years after the discovery of the variation, it was found that it did not remain constant: for the easterly variation observed in England gradually decreased till the needle pointed to the true north, and then increased to the westward, and is now above two points.

As all the courses steered by a compass must be corrected for the variation to obtain the true courses, it is of great importance to the navigator to know how to find the variation at any time; to do this it is necessary to find the magnetic amplitude or azimuth of a celestial object, which may be done as follows:

*To observe an amplitude by an azimuth compass.**

When the centre of the sun is about one of his diameters† above the horizon, turn the compass round in the box, until the centre of the sun is seen through the narrow slit which is in one of the sight vanes, exactly on the thread which bisects the slit in the other;‡ at that instant push the stop which is in the side of the box against the edge of the card, and the degree and parts of a degree which stand against the middle line on the top will be the magnetic amplitude of the sun at that time, which is generally reckoned from the east or west point of the compass.

To observe an azimuth by an azimuth compass.

Turn the compass round in the box until the centre of the sun is seen through the narrow slit which is in one of the sight vanes, exactly on the thread which bisects the slit on the other, or until the shadow of the thread falls directly along the line of the horizontal bar,‡ the card is then to be stopped, and the degree and parts of a degree which stand against the middle line of the stop, will be the magnetic azimuth of the sun at that time, which is generally reckoned from the north in north latitude, and from the south in south latitude.§ At the time of making this observation, you must also observe the altitude of the sun, in order to obtain the true azimuth.

What is here said of the sun, is alike applicable to the moon, planets, and stars.

TO FIND THE TRUE AMPLITUDE.

RULE.

BY LOGARITHMS.—*To the log-secant of the latitude (rejecting 10 in the index) add the log. sine of the sun's declination;|| the sum will be the log. sine of the true amplitude or distance of the sun from the east or west point, towards the north in north declination, but towards the south in south declination.*

BY INSPECTION.—*Find the declination at the top of Table VII. and the latitude in the side column; under the former, and opposite the latter, will be the true amplitude.* When great accuracy is required, you may proportion for the minutes of latitude and declination.

* The figure of an azimuth compass, furnished with sight vanes, is given in Plate VI. fig. 5. The card of this compass is similar to that of a common compass.

† The observation is to be taken at that altitude on account of the dip, refraction and parallax, the correction of altitude depending on these causes being in general nearly equal to the sun's diameter.

‡ If the instrument is furnished with a magnifying glass fixed to one of the vanes, you may (instead of proceeding as above) turn the compass-box until the vane is directed towards the sun, and when the bright speck (or rays of the sun collected by the magnifying glass) falls upon the slit of the other vane, or upon the line in the horizontal bar, the card is to be stopped, and the divisions read off as above.

§ If the compass vibrate considerably at the time of making the observations, it would be conducive to accuracy to take several azimuths and altitudes, and to take the mean of all the azimuths and all the altitudes, and work the observation with the mean azimuth and altitude. The same is to be observed in taking an amplitude.

|| The declination of the sun at noon is given in the Nautical Almanac, and in Table IV. and must be corrected for the longitude of the ship and the hour of the day, by means of Table V.

VARIATION OF THE COMPASS.

113

EXAMPLE I.

Required the sun's true amplitude at rising, in the latitude of $39^{\circ} 0' N.$ on the 22d of December, 1820?

BY LOGARITHMS.

Latitude..... $39^{\circ} 0'$ log. sec. 0.10956
 Sun's declin. ... $23^{\circ} 28'$ log. sine 9.60015
 True ampli. $30^{\circ} 49'$ log. sine 9.70961

BY INSPECTION.

Under the declination $23^{\circ} 28'$ and opposite the latitude 39° stands the true amplitude $30^{\circ} 49'$.

Hence the true bearing or amplitude of the sun at rising is E. $30^{\circ} 49' N.$ and at setting it is W. $30^{\circ} 49' S.$

EXAMPLE II.

Required the moon's true amplitude at setting, in the latitude of $35^{\circ} 8' N.$ when her declination is $13^{\circ} N.$?

BY LOGARITHMS.

Latitude $35^{\circ} 8'$ log. sec. 0.08734
 Moon's declin. $13^{\circ} 0'$ log. sine 9.35209
 True ampli. ... $15^{\circ} 59'$ log. sine 9.43943

BY INSPECTION.

Under the declination 13° , and opposite the latitude 35° stands $15^{\circ} 56'$, which is nearly the true amplitude; the exact value may be found by finding the amplitude for 16° latitude, and proportioning the difference for the miles in the latitude.

Hence the true amplitude at setting is W. $15^{\circ} 59'$ North. and at rising E. $15^{\circ} 59' N.$

EXAMPLE III.

Required the sun's true amplitude in the latitude of $42^{\circ} 30' N.$ when his declination was $20^{\circ} N.$?

BY LOGARITHMS.

Latitude..... $42^{\circ} 30'$ log. sec. 0.13237
 Sun's declin. ... $20^{\circ} N.$ log. sine 9.53405
 True ampli. $27^{\circ} 39'$ log. sine 9.66642

BY INSPECTION.

Under the declination 20° and opposite the latitudes 42° and 43° , stand $27^{\circ} 24'$ and $27^{\circ} 53'$; the mean of these gives the true amplitude for the latitude of $42^{\circ} 30' = 27^{\circ} 39'.$

Hence the amplitude at setting is W. $27^{\circ} 39' N.$ and at rising E. $27^{\circ} 39' N.$

To find the true azimuth at any time.

At the time of observing the magnetic azimuth, you must also observe the altitude of the object; this altitude must be corrected as usual for the dip, parallax, refraction, &c. in order to obtain the true altitude; you must also find the declination of the object, and the latitude of the place of observation, and then the true azimuth may be calculated by the following

RULE. Add together the polar distance, the latitude, and the true altitude, take the difference between the half sum and the polar distance, and note the remainder. Then add together the log. secant of the latitude, the log. secant of the altitude (rejecting 10 in each index) the log. co-sine of the half sum, and the log. co-sine of the remainder; half the sum of these four logarithms will be the log. co-sine of half the true azimuth, which being doubled will give the true azimuth, reckoned from the north in north latitude, from the south in south latitude.

In observations of the altitude of the sun's lower limb (by a fore-observation) it is usual to add 1. the effect of dip, parallax, and semi-diameter. The refraction is to be subtracted from the sum, and the remainder will be the true altitude nearly.

The declination is to be found according to the directions in the note, in the last page. The polar distance of the sun, moon, or star, is the distance from the elevated pole, and is found by subtracting the declination of the object from 90° , when the latitude and declination are of the same name, but by adding to 90° when of different names.

VARIATION OF THE COMPASS.

EXAMPLE I.

In latitude $51^{\circ} 32' \text{ N.}$ the sun's true altitude was found to be $39^{\circ} 28'$, his declination being then $16^{\circ} 38' \text{ N.}$ —required the true azimuth?

Polar distance.....	$73^{\circ} 22'$		
Latitude	$51^{\circ} 32'$	secant	0.20617
Altitude.....	$39^{\circ} 28'$	secant	0.11239
<hr/>			
Sum	$164^{\circ} 22'$		
<hr/>			
Half sum.....	$82^{\circ} 11'$	co-sine	9.13355
Polar distance.....	$73^{\circ} 22'$		
<hr/>			
Remainder	$8^{\circ} 49'$	co-sine	9.99484
			<hr/>
			2)19.44695
			<hr/>
Half sum log. co-sine	$58^{\circ} 4'$		9.72347
	2		

True Azimuth $116^{\circ} 8'$ from the north.

The logarithm 9.72347 of this example is also the co-sine of $121^{\circ} 56'$, which doubled gives another azimuth $243^{\circ} 52'$, the former being $116^{\circ} 8'$. One of these corresponds to an observation in the forenoon, the other to an afternoon observation.

EXAMPLE II.

In latitude $42^{\circ} 16' \text{ S.}$ the sun's true altitude was found to be $18^{\circ} 40'$, his declination being then $7^{\circ} 38' \text{ N.}$ —required the true azimuth?

Polar distance.....	$97^{\circ} 38'$		
Latitude	$42^{\circ} 16'$	secant.....	0.13076
Altitude.....	$18^{\circ} 40'$	secant.....	0.02347
<hr/>			
Sum.....	$158^{\circ} 34'$		
<hr/>			
Half sum	$79^{\circ} 17'$	co-sine	9.26940
Polar distance	$97^{\circ} 38'$		
<hr/>			
Remainder	$19^{\circ} 21'$	co-sine	9.97734
			<hr/>
			sum.....
			19.40097
			<hr/>
Half sum log. co-sine ..	$59^{\circ} 53'$		9.70049
	2		

True Azimuth $119^{\circ} 46'$ from the south.

QUESTIONS TO EXERCISE THE LEARNER.

Question I. Given the sun's altitude corrected for dip, refraction, &c. $20^{\circ} 46'$, his declination $17^{\circ} 10' \text{ S.}$ and the latitude of the place $40^{\circ} 38' \text{ N.}$ Required the true azimuth?

Answer. $137^{\circ} 50'$ from the north.

Question II. What is the sun's azimuth in the latitude of $26^{\circ} 30' \text{ N.}$ in the forenoon, when his correct central altitude is $24^{\circ} 28'$ and his declination $22^{\circ} 40' \text{ N.}$?

Answer. $75^{\circ} 44'$ from the north.

Question III. At the Island of St. Helena the sun's true central altitude was found to be $30^{\circ} 23'$ in the forenoon, his declination being then $22^{\circ} 58' \text{ S.}$ Required the azimuth at that time?

Answer. $72^{\circ} 21'$ from the south.

Question IV. What point of the compass did the star Aldebaran bear on, in the latitude of $34^{\circ} 23' \text{ S.}$ on January 1, 1804, when the correct altitude of that star was $22^{\circ} 26'$?

Answer. $130^{\circ} 16'$ from the south.

Having the true magnetic amplitude or azimuth, to find the variation.

Having found the true and magnetic amplitude or azimuth, the variation may be easily deduced therefrom by the following rule, in which the amplitude is reckoned from the east or west point of the horizon, and is called north when to the northward of those points, but south when to the south-

ward. The azimuth is reckoned from the north in north latitudes, but from the south in south latitudes, and is named east when falling on the east side of the meridian, otherwise west. If the observed and true amplitudes be both north or both south, their difference will be the variation; but if one be north and the other south, their sum will be the variation. If the true and observed azimuths be both east or both west, their difference will be the variation, otherwise their sum; and the variation will be easterly when the point representing the true bearing is to the right hand of the point representing the magnetic bearing, but westerly when to the left hand; the observer being supposed to look directly towards the point representing the magnetic bearing.

EXAMPLE I.

Suppose the sun's magnetic amplitude at rising is E. $26^{\circ} 12'$ N. and the true amplitude E. $14^{\circ} 20'$ N. Required the variation?

From the greater	E. $26^{\circ} 12'$ N.
Take the lesser	E. $14^{\circ} 20'$ N.
Remains variation	$11^{\circ} 52'$ E.

The variation in this example is easterly, because the true amplitude falls to the right of the magnetic.

EXAMPLE II.

The moon's true amplitude at rising was found to be E. $15^{\circ} 20'$ N. and her magnetic amplitude E. $10^{\circ} 0'$ S. Required the variation?

True amplitude	E. $15^{\circ} 20'$ N.
Magnetic amplitude	E. $10^{\circ} 0'$ S.
The sum is the variation	$25^{\circ} 20'$ W.

EXAMPLE IV.

The star Aldebaran was observed at rising to bear by compass E. N. E. when the true amplitude was N. E. by E.—Required the variation?

True amp. N. E. by E. or E.	$33^{\circ} 45'$ N.
Mag. amp. E. N. E. or E.	$22^{\circ} 30'$ N.
Difference is the variation	$11^{\circ} 15'$ W.

EXAMPLE III.

The sun's true azimuth being N. 80° E. and his magnetic azimuth N. 60° E. it is required to find the variation?

True azimuth	N. 80° E.
Magnetic azimuth	N. 60° E.
Diff. is the variation	20° E.

EXAMPLE V.

The true amplitude of the planet Jupiter was E. 10° N. when his magnetic amplitude was E. 20° S.—Required the variation?

True amplitude	E. 10° N.
Magnetic amplitude	E. 20° S.
Sum is variation	30° W.

To calculate the variation by observing the sun's azimuth when at equal altitudes in the forenoon and afternoon.

The variation of the compass may also be determined by observing the magnetic azimuths of the sun in the morning and evening when at the same altitude, the observer being supposed to be at the same place at both observations; for it is evident that if the declination of the sun did not vary during the time elapsed between the observations, the middle point of the compass between the two bearings would be the bearing of the true north or south point of the horizon, at the place of observation, and the difference between that bearing and the north or south point of the compass would be the variation.

In this kind of observations it will be convenient always to estimate the magnetic azimuths from the south point of the compass, calling them east or west, as before directed, and this method is supposed to be made use of in the following rule. Then, if one azimuth be east and the other west, half their difference will be the variation, otherwise their half sum, and the variation will be of the same name as their greater azimuth, excepting, however, where the half sum is taken and exceeds 90° , in which case its supplement will be the variation of a different name from the azimuth. The variation being always supposed less than 90° .

If the declination of the sun varies during the elapsed time between the observations, (as is generally the case) an allowance may be made for that variation by applying a correction to the afternoon azimuth, calculated by the following rule.*

* The rule given in Doctor Mackay's "Complete Navigator" is inaccurate.

RULE. Find from Table IV. the daily variation of the sun's declination on the day of observation. Then to the constant logarithm 9.1249 add the log. co-sine of the latitude of the place, the log. sine corresponding to the elapsed time between the observations found in the column P. M. the Prop. Log. of the daily variation of the sun's declination, and the Prop. Log. of the elapsed time*, estimating hours and minutes as minutes and seconds, the sum, rejecting 30 in the index, will be the Prop. Log. of the correction to be applied to the western azimuth, by subtracting when the sun is approaching towards the northern hemisphere, otherwise by adding.† The azimuth thus corrected is to be used in estimating the variation instead of the observed azimuth.

It is not necessary in this calculation to find the latitude or declination to any great degree of accuracy, which is the greatest advantage of the method; another of the advantages consists in being able to take a great number of observations, and applying the correction at one operation to the variation deduced from the mean of all the observations, so that, when great accuracy is required, as in taking observations ashore, this method may be used with success; and it is evident that it is alike applicable to the moon or any heavenly body, but the observations must be taken in the same place, as it would increase the calculation considerably, to make an allowance for the change of place, as well for the change of declination; and it would be better in this case to calculate each observation separately by the rules before given.

EXAMPLE.

Suppose that on the 10th of April, 1820, in the latitude of $42^{\circ} 29' N.$ long. $50^{\circ} W.$ the sun's morning azimuth was observed to be $S. 54^{\circ} 24' E.$ and in the evening, when the sun was at the same altitude, was $S. 39^{\circ} 46' W.$ the elapsed time between the observations being 6h. 20m.—Required the variation?

Constant logarithm	9.1249
Latitude $42^{\circ} 29'$ co-sine	9.8677
Elapsed time 6h. 20m. Sine	9.8676
Daily variation of declination $22' P.$ L.....	.9128
Elapsed time 6h. 20m. taken as $6' 20'' P.$ L.....	1.4536

Corr. western azimuth $11'$ nearly P. L.	1.2266
Western azimuth $S. 39 46 W.$	

Corrected azimuth $S. 39 35 W.$	
Morning azimuth $S. 54 24 E.$	

Difference 14 49 The half of which $7^{\circ} 24'$ is the variation, which is easterly, because the greater azimuth $S. 54^{\circ} 24' E.$ is easterly.

The variation, thus found, is to be allowed on all courses steered by the compass to obtain the true courses. To make this allowance, you must look towards the point of the compass the ship is sailing upon, and allow the variation from it *towards the right hand, if the variation be east, but to the left hand, if the variation be west.* Thus, if a ship steer $S. E.$ with one point westerly variation, the true course will be $S. E.$ by $E.$ If the variation is one point easterly, the course will be $S. E.$ by $S.$

In the following Table are collected a few observations of the variation, made at different times, and in different places.

* The elapsed time may be determined by any common watch, but if none was used in the observations, it may be determined as follows. If one of the observed azimuths was east and the other west, take half their sum, otherwise half their difference, and to the log. sine of this half sum (or half difference) add the log. secant of the sun's declination, and the log. co-sine of the sun's correct altitude at the time of taking the azimuth, the sum (rejecting 20 in the index) will be the log. sine to be used in the above calculation, and this logarithm will correspond to the elapsed time, marked in the column P. M. of Table XXVII.

† In this rule it is supposed that the bearing of the sun, by the afternoon observation, is to the westward of the meridian by compass; but if there be a great variation, that bearing might be to the eastward of the meridian by the compass, and in that case the correction of the western azimuth must be applied in a contrary manner to the above directions.

VARIATION OF THE COMPASS.

117

Places observed at.	Latitude.	Longitude from Greenwich.	Year of Observation.	Variation Observed.
Cambridge, (Mass.)	42° 33' N.	71° 8' W.	1703	9° 0' W.
			1742	8 0 W.
			1757	7 20 W.
			1761	7 14 W.
			1763	7 0 W.
			1782	6 46 W.
Boston.	42 23 N.	71 4 W.	1742	8 0 W.
Beverly (town.)	42 36 N.	70 52 W.	1781	7 2 W.
Salem.	42 33 N.	70 52 W.	1805	5 57 W.
			1809	5 20 W.
London.	51 31 N.	0 8 W.	1580	11 15 E.
			1672	2 30 W.
			1780	22 41 W.
Paris.	48 50 N.	2 20 E.	1550	8 0 E.
			1660	0 0
			1769	20 0 W.
Punchal Road.	32 38 N.	17 5 W.	1792	18 35 W.
St. Croix Road.	28 27 N.	16 16 W.	1792	17 35 W.
Bonavista.	16 6 N.	22 53 W.	1792	12 36 W.
St. Jago (Praya Bay.)	14 52 N.	23 30 W.	1769	11 10 W.
			1792	12 48 W.
Isle of May.	15 4 N.	22 46 W.	1792	12 00 W.
Ascension.	7 56 S.	14 21 W.	1678	1 0 E.
			1776	10 45 W.
St. Helena.	15 55 S.	5 51 W.	1677	0 40 E.
			1776	13 15 W.
			1794	16 16 W.
Tristan d'Acunha.	37 7 S.	11 38 W.	1792	7 0 W.
Cape of Good Hope.	34 26 S.	18 23 E.	1776	21 0 W.
Cape Lagullas.	34 53 S.	20 10 E.	1600	0 0
			1776	11 0 W.
			1776	21 40 W.
			1790	23 30 W.
Island St. Paul.	37 56 S.	77 28 E.	1677	23 30 W.
			1792	19 30 W.
Isle of Bourbon.	20 52 S.	55 31 E.	1795	15 33 W.
Java Head.	6 46 S.	104 50 E.	1676	3 10 W.
			1786	0 54 W.
Batavia.	6 10 S.	106 51 E.	1793	0 30 W.
At Sea.	29 10 N.	28 52 W.	1795	16 00 W.
At Sea.	27 00 N.	23 43 W.	1795	15 44 W.
At Sea.	15 28 N.	20 43 W.	1795	12 5 W.
At Sea.	12 14 N.	20 5 W.	1795	11 39 W.
At Sea.	9 47 N.	20 15 W.	1795	11 48 W.
At Sea.	8 54 N.	20 15 W.	1795	10 50 W.
At Sea.	5 46 N.	20 54 W.	1795	11 00 W.
At Sea.	3 16 N.	21 27 W.	1795	10 47 W.
At Sea.	0 0	24 20 W.	1795	8 43 W.
At Sea.	2 33 S.	24 51 W.	1795	7 5 W.
At Sea.	5 48 S.	26 54 W.	1795	5 24 W.
At Sea.	7 59 S.	27 54 W.	1795	4 14 W.
At Sea.	9 27 S.	27 55 W.	1795	3 33 W.
At Sea.	13 19 S.	26 58 W.	1795	3 54 W.
At Sea.	19 47 S.	25 56 W.	1795	2 50 W.
At Sea, near Trinidad.	20 28 S.	23 44 W.	1796	2 35 W.
At Sea.	21 32 S.	25 27 W.	1795	2 25 W.
At Sea.	23 43 S.	23 45 W.	1795	2 31 W.
At Sea.	28 11 S.	18 45 W.	1795	5 28 W.
At Sea.	36 5 S.	6 0 W.	1795	11 10 W.
At Sea.	36 38 S.	0 15 E.	1795	13 40 W.
At Sea.	36 12 S.	4 16 E.	1795	15 19 W.
At Sea.	37 20 S.	7 26 E.	1795	16 57 W.
At Sea.	36 48 S.	19 27 E.	1795	24 33 W.
At Sea.	21 54 S.	53 41 E.	1795	13 59 W.
At Sea.	0 0	32 36 W.	1795	3 0 W.

By the preceding table it appears that the variation at Cambridge, in the state of Massachusetts, is decreasing at the rate of about $1\frac{1}{2}$ minutes per year, and by late observations at Salem, the needle there appears to be still approaching towards the true meridian. At London and Paris the variation formerly increased 10 or 11 minutes per year, but by some late observations made in London, it appears to be nearly stationary. Off the Cape of Good Hope the annual increase is about 7 minutes.

Besides this annual change of the variation, there is also a small *diurnal* change, which at London, Paris and Cambridge (Mass.) is from $10'$ to $15'$. By this quantity the absolute variation at those places increases from about 8 A. M. to 2 P. M. when the needle becomes stationary for some time; after that, the variation decreases, and the needle comes back again to its former situation, or nearly so, in the night or by the next morning.

In addition to the observations contained in the preceding table, it may be observed, that the variation which (at present) is less than $\frac{1}{2}$ point W. near Cape Cod, decreases in going to the westward along the coast of the United States of America, so that near Cape Hatteras it is scarcely sensible, and farther to the westward becomes easterly. In the leeward West India islands it is about $\frac{1}{2}$ point E. and in the windward islands $\frac{1}{4}$ point E. Along the northern shore of the Brazils there is a small easterly variation which decreases in proceeding to the eastward towards Cape Roque, where it is scarcely sensible; in proceeding farther to the southward along the coast of America, the easterly variation increases so as to be above 2 points E. near Cape Horn, and from thence gradually decreases along the coast of Chili and Peru, so as to be about $\frac{3}{4}$ point E. under the equator near Quito; but in proceeding to the northward toward the N. W. coast of America, the easterly variation increases to more than 2 points.

On the contrary in proceeding to the eastward of the United States of America, the westerly variation increases, being nearly 1 point W. a little to the eastward of Cape Sable (Nova Scotia) and about 2 points W. on the E. part of Newfoundland, and at the Western Islands. At the Orkney islands it is $2\frac{1}{2}$ points westerly and is nearly the same in the English Channel, and on the coasts of England, Scotland and Ireland. On the coast of Holland, it is from 2 to $2\frac{1}{2}$ points W. In the Cattegat and Sound about $1\frac{1}{2}$ points W. In the Western part of the Baltic about $1\frac{1}{4}$ points. At the entrance of the Gulf of Finland 1 point W. In the Bay of Biscay about $2\frac{1}{4}$ points W. Near Cape St. Vincents 2 points W. In the Mediterranean from $1\frac{1}{4}$ to $1\frac{1}{2}$ points W. Near Cape Verd (Africa) $1\frac{1}{4}$ point W. and from thence gradually increases along the western shore of Africa towards the Cape of Good Hope, and is there above 2 points W. and from thence increases towards Cape Lagullas and a little to the eastward to $2\frac{1}{2}$ points or $2\frac{3}{4}$ points W. and then decreases in proceeding along the eastern shore of Africa, and is about 1 point westerly at the entrance of the Red Sea. In the Arabian Sea, Bay of Bengal, Java Sea, China Sea, and off the coast of Sumatra, it is very small, and on the S. E. part of New Holland is about $\frac{1}{4}$ point E.

Ships sailing for India generally cross the equator between the longitude of 18° and 24° west. The variation at the latter place was about $8^\circ 48'$ W. in the year 1795, as I have found by repeated observations, and the annual increase is about 6 minutes. If, in crossing the equator, you should find a greater variation, you would probably be to the eastward of 24° W. but less, to the westward of 24° W. The alteration in the longitude is in that place about 2 degrees for 1 degree of variation. But there is always a great uncertainty attending this kind of observations, made with a common compass, since it is not uncommon to find 2 or 3 degrees difference between an azimuth in the morning and evening, when the ship during that time has been nearly stationary; the same difference will sometimes be found merely from making the observation when the ship is on a different tack. This is owing to the iron in the ship which attracts the compass by a force which is generally situated in a point near the centre of the ship. When this point is

The compass are in the magnetic meridian of the compass, the true variation is obtained, but as soon as the position of the ship is changed so as to bring this point to the eastward or westward of the magnetic meridian passing through the compass, a corresponding change or observation in the variation to the eastward or westward is immediately perceived. This deviation sometimes amounted to 8° or 9° in the surveys of New Holland. This has since been confirmed by various observations in different places, particularly in the voyages towards the north pole lately made by order of the English government. The method which was at first used to correct this error, which is sometimes of considerable importance in nautical surveys, where great accuracy is required, was to place the compass always in the same part of the ship, and to find by actual observation, the greatest deviation arising from this local attraction, which is when the ship's head is directed east or west. The deviation when the ship's head is in any other direction, is found by entering Table I. or Table II. in the page corresponding to that direction as a course, and with that greatest error in minutes in the distance column, the corresponding number in the departure column will be the required correction nearly. Thus if the deviation was 2° S. or $128'$ when the ship's head was directed towards the east, the deviation when in the direction of *one point* from the meridian, (that is N. by E. N. by W. S. by E. or S. by W.) would be found by entering Table I. in the page for *one point*, or with the distance 128, the corresponding departure $25'$ would be the correction to be applied on all bearings taken by the compass when in that situation. Mr. Barlow has invented a method of correcting this error, making use of a curious property of the attractive force of iron on the compass, it having been found that this force depends on the *attractive surface*, and not wholly on the quantity of iron; so that a *solid globe* of iron 30 inches in diameter, would affect the compass exactly in the same manner as a *hollow shell* of iron of the same diameter made of sheet iron only *one tenth* of an inch in thickness, though this shell could not contain but *one hundredth part* the quantity of iron which the globe does. Mr. Barlow therefore proposed to have a sheet of iron placed abaft the compass of such dimensions, and at such a distance, as should be found by experiment to bring the needle back to the magnetic meridian when the ship's head was east or west, then keeping the iron in that position it could correct the error of the local attraction of the ship in every direction of the ship's head. This method has been tested by experiment and found to succeed admirably. It has also been attended with the great advantage of leaving the compass free to act by the natural magnetism of the earth in high latitudes, where the force is much enfeebled by the obliquity of its direction on account of the greatness of the dip. In the voyages above named it was found that the compasses thus furnished traversed freely and accurately, when those of the common form moved very irregular, and were in some cases almost useless.

On the Dip of the Magnetic Needle.

If the needle of a compass be exactly balanced on its point in a horizontal position, and then the magnetic virtue be communicated, the needle will point towards the north, and will also be inclined to the horizon, the north point of the needle tending downwards, and the south point upwards in northern climates, and the contrary in southern climates. This inclination of the needle to the horizon is called *The Dip of the Magnetic Needle*, which is different in different places, though it has been found to remain nearly the same in the same place, since its discovery in the year 1576, in which year at London the dip was $71^{\circ} 50'$, in 1723 it was 74° or 75° , and at present is about 72° . Messrs. Humbolt and Biot published a method by which the dip may be calculated for any given place in north latitudes to a considerable degree of accuracy. This method is explained in the 22d vol. of *Tilloch's Magazine*, and is in substance as follows:

According to their theory there are *two magnetic poles*, one in the latitude of $72^{\circ} 1' N.$ and in the longitude of $27^{\circ} 42' W.$ from Greenwich, the other diametrically opposite, in the latitude of $72^{\circ} 1' S.$ and in the longitude of

* Capt. Parry, in his voyage to the north, found the northern pole to be nearly in $70^{\circ} N.$ and $90^{\circ} W.$

152° 18' E. The great circle of the earth 90° distant from these poles is called the *magnetic equator*. On the magnetic equator the dip is nothing, and at the poles is 90°, at any other point on the surface of the earth the dip varies with the distance from the magnetic pole: This distance may be calculated by common spherical trigonometry, or, (which is much more simple and sufficiently accurate for this purpose) by measuring the distance on a terrestrial globe from the magnetic pole to the place for which the dip is to be calculated; then to the log. co-tangent of this distance add the constant logarithm 0.30103, the sum will be the log. tangent of the dip. The dip was calculated on these principles for twenty-eight places in Europe, Asia, Africa and America, and in ten places the theory did not differ 1° from actual observations, and in five places did not differ 2°, but at Spitzbergen the difference was between 4° and 5°. Considering the difficulty of observing the dip with accuracy, the difference between the theory and observation may be considered as nearly within the limits of the errors of observation, and this difference may be rendered less by introducing a small correction depending on the longitude of the place of observation referred to the magnetic equator.

The methods proposed for finding the longitude by the variation and by the dip, will be hereafter explained.



TO FIND THE LATITUDE BY OBSERVATION.

THE latitude of a place being its distance from the equator, is measured by an arch of the meridian contained between the zenith and the equator: hence, if the distance of any heavenly body from the zenith when on the meridian, and the declination of the object be given, the latitude may be thence found.

The meridian zenith distance of any object may be found by observing its altitude when on the meridian, or by observing one altitude taken at a given hour from passing the meridian, or by two altitudes taken out of the meridian and the elapsed time between the observations—each of these methods will be explained by proper examples.

Altitudes of the sun and moon taken at sea require four corrections in order to obtain the true altitude of their centres; these are for Semi-diameter, Dip, Refraction, and Parallax.* When a planet or star is observed, the corrections for dip and refraction only are to be applied, as the semi-diameter and parallax of a planet are but a few seconds, and may be neglected in finding the latitude at sea.

In a fore-observation with a quadrant, sextant or circle, the semi-diameter is to be added if the lower limb was observed, but subtracted if the upper limb was observed. The dip and refraction are to be subtracted and the parallax to be added, and the central altitude will be thus obtained, which being subtracted from 90° will give the true zenith distance.

In a back-observation with a quadrant, the semi-diameter is to be subtracted if the lower limb was observed, but added if the upper limb was observed. The dip and parallax are to be added, and the refraction subtracted, and the central altitude will be obtained, which being subtracted from 90° will give the true zenith distance.

In a back-observation with a sextant or circle, by measuring the supplement of the altitude by bringing the lower limb of the image of the object to touch the back horizon, the semi-diameter and refraction must be added to

* The semi diameter of the sun may be found in the 3d page of the month of the Nautical Almanac and is nearly 16'. The sun's parallax is to be found in Table XIV. The refraction in Table XII. The dip in Table XIII. The semi-diameter and parallax of the moon may be found from the Nautical Almanac, as will be explained hereafter. It may also be observed, that it is usual to add 12' for the correction for semi-diameter, dip and parallax, in a fore-observation of the sun's lower limb, taken on the deck of a common sized vessel, and by subtracting the refraction from the sum, the true altitude will be obtained nearly, and it ought always to be kept in mind that the refraction at low altitudes is of too much importance to be neglected.

TO FIND THE LATITUDE BY OBSERVATION. 121

the altitude given by the instrument, and the dip and parallax subtracted therefrom, and by subtracting 90° from the remainder, the true zenith distance will be obtained.

To find the Latitude by the meridian altitude of any object.

Having obtained the true meridian zenith distance by either of these methods, you must then find the declination of the object at the time of observation. This may be found for the sun by the Nautical Almanac or by means of Tables IV. and V. in the manner before explained. The declination of a fixed star may be easily found by inspection in Table VIII. The declination of the moon or a planet may be found in the Nautical Almanac in a manner which will be hereafter explained. Having the meridian zenith distance and declination, the latitude is to be found by the following rules.

CASE I.

When the object rises and sets.

RULE. If the object bear south, when upon the meridian, call the zenith distance north; * but if the bearing be north you must call the zenith distance south. Place the zenith distance under the declination, and if they are of the same name add them together, but if they are of different names, take their difference; this sum or difference will be the latitude which will be of the same name as the greatest number.

CASE II.

When the object does not set, but comes to the meridian above the horizon twice in 24 hours.

Many stars are always above the horizon of certain places of the earth, and in high latitudes the sun is sometimes above the horizon for several days, in which case the meridian altitude may be observed twice in 24 hours, that is, once at the greatest height above the pole, and again at the lowest height upon the meridian below the pole. In the former case, the latitude is to be found by the preceding rule, but in the latter, by the following

RULE. Add the complement of the declination to the meridian altitude; the sum will be the latitude, of the same name as the declination

NOTE. When the sun or star is on the equator, or has no declination, the zenith distance will be equal to the latitude of the place, which will be of the same name as the zenith distance.

When the sun or star is in the zenith, the declination will be equal to the latitude, and it will be of the same name as the declination.

To find the latitude by the meridian altitude of the sun or star.

EXAMPLE I.

Suppose that at the end of the sea day, June 21, 1824, in the longitude of 60° W. the meridian altitude of the sun's lower limb bearing south, was found by a fore-observation to be $40^\circ 6'$ —required the latitude, supposing the correction of the observed altitude for parallax, dip, and semi-diameter to be 12 miles?

Observed altitude.....	$40^\circ 6'$
Par. dip, and semi-diam. add	12
Sum	$40 18$
Refraction.....subtract	1
True altitude.....	$40 17$
Subtract from	$90 00$
True zenith distance	$49 43$ N.
Sun's declination, Tab. IV.....	$23 28$ N.
Latitude	$73 11$ N.

EXAMPLE II.

Suppose that at the end of the sea day, April 13, 1824, in the longitude of 140° E. from Greenwich, the altitude of the sun's lower limb by a fore-observation was $60^\circ 25'$ when on the meridian and bearing south, the correction for dip, semi-diameter and parallax being 12 miles—required the latitude?

Observed altitude.....	$60^\circ 25'$
Correction.....add	12
True altitude.....	$60 37$
Subtract from	$90 00$
True zenith distance	$29 23$ N.
Sun's declination, Tab. IV. }	
cor. by Tab. V. for long. }	$9 21$ N.
Latitude.....	$38 44$ N.

In this rule the sun is supposed to be the fixed point, and the zenith is referred to it. Thus, if the sun were south from an observer (or from his zenith) the zenith bears north from the sun, and it is this bearing which is used in the rule.

The refraction being small is here neglected.

EXAMPLE III.

Suppose that at the end of the sea day, May 15, 1824, in the meridian of Greenwich, the meridian altitude of the sun's lower limb bearing north was found by a fore-observation to be $30^{\circ} 6'$, the correction for parallax, dip and semi-diam. being 12 miles—required the latitude?

Observed altitude.....	$30^{\circ} 6'$
Par. dip, and semi-diam....add	12
Sum	$30^{\circ} 18'$
Refraction	2
True altitude	$30^{\circ} 16'$
Subtract from.....	$90^{\circ} 00'$
True zenith distance	$59^{\circ} 44'$ S.
Sun's declination	$18^{\circ} 55'$ N.
Latitude.....	$40^{\circ} 49'$ S.

EXAMPLE IV.

Suppose that at the end of the sea day, Nov. 17, 1824, in the longitude of 80° E. from Greenwich, by a fore-observation the meridian altitude of the sun's lower limb was $50^{\circ} 6'$, bearing south; the eye of the observer being 17 feet above the surface of the sea—required the latitude?

Observed altitude.....	$50^{\circ} 6'$
Sun's semi-diam. ....add	16
	$50^{\circ} 22'$
Subtract dip and refraction.....	5
True altitude*	$50^{\circ} 17'$
Subtract from.....	$90^{\circ} 00'$
True zenith distance.....	$39^{\circ} 43'$ N.
Sun's dec. cor. by Tab. V.....	$19^{\circ} 1'$ S.
Latitude	$20^{\circ} 42'$ N.

EXAMPLE V.

By a fore-observation, the meridian altitude of the sun's lower limb was found to be $40^{\circ} 20'$ bearing south of the observer, the declination being $9^{\circ} 56'$ N. and the eye 26 feet above the horizon—required the latitude of the place?

Observed altitude	$40^{\circ} 20'$
Semi-diameter	16
	$40^{\circ} 36'$
Dip $5'$, refraction $1'$, ....sub.	6
True altitude sun's centre*.....	$40^{\circ} 30'$
Subtract from.....	$90^{\circ} 00'$
Zenith distance.....	$49^{\circ} 30'$ N.
Declination	$9^{\circ} 56'$ N.
Latitude.....	$59^{\circ} 26'$ N.

EXAMPLE VI.

By a back-observation with a quadrant of reflection, the meridian altitude of the sun's lower limb was $25^{\circ} 12'$ when the declination was $21^{\circ} 14'$ S. and the eye of the observer 4 feet above the horizon, the sun bearing S.—required the lat. of the place of observation

Observed altitude	$25^{\circ} 12'$
Semi-diameter.....sub.	16
	$24^{\circ} 56'$
Dip	6
	$25^{\circ} 2'$
Refraction	2
True alt. of sun's centre*.....	$25^{\circ} 0'$
True zenith distance	$65^{\circ} 0'$ N
Declination	$21^{\circ} 14'$ S
Latitude	$43^{\circ} 46'$ N

EXAMPLE VII.

Suppose that on January 1, 1824, an observer 17 feet above the water finds by a fore-observation that the altitude of Sirius is $53^{\circ} 33'$ when passing the meridian to the southward; required the latitude of the place of observation?

Observed altitude	$53^{\circ} 33'$
Dip of horizon	4
	$53^{\circ} 29'$
Refraction	1
	$53^{\circ} 28'$
True zenith distance	$36^{\circ} 32'$ N
Sirius' declin. Tab. VIII.†.....	$16^{\circ} 29'$ S
Latitude	$20^{\circ} 3'$ N

EXAMPLE VIII.

Suppose that on the 13th June, 1824, sea account, an observer in a high northern latitude and in the longitude of 65° W. from Greenwich, his eye being 20 feet above the surface of the water, observed by a fore-observation the altitude of the sun's lower limb on the meridian below the pole $8^{\circ} 14'$ —required the latitude?

The sun being below the pole at 12 hours before the end of the sea day June 13, the correction of declination corresponding in Table V. is— $1^{\circ} 46''$, and the correction for 65° W. long. is $+0^{\circ} 39''$, hence both corrections make nearly $1'$ to be subtracted from the declination at noon $23^{\circ} 14'$ N. which will give the declination at the time of observation $23^{\circ} 13'$ N. the comp. of which is $66^{\circ} 47'$.

Observed alt. sun's lower limb	$8^{\circ} 14'$
Semi-diameter	16
	$8^{\circ} 30'$
Dip.....sub.	4
	$8^{\circ} 26'$
Refraction	6
True alt. of sun's centre†.....	$8^{\circ} 20'$
Complement of declination	$66^{\circ} 47'$ N
Latitude.....	$75^{\circ} 7'$ N

* The parallax being small is here neglected, and the sun's semi-diameter is supposed to be $16'$.
† The north polar distances of these bright stars are given for every 10 days in the Nautical Almanac. when great accuracy is required, the declinations deduced from these may be used instead of the numbers in Table VIII.
‡ The parallax being small is neglected.

TO FIND THE LATITUDE BY OBSERVATION. 123

EXAMPLE IX.

Suppose that on January 10, 1824, an observer 18 feet above the water, finds the altitude of the north star, when on the meridian below the pole, to be $36^{\circ} 23'$ by a fore-observation; required the latitude of the place of observation?

Observed altitude	$36^{\circ} 23'$
Subtract dip. $4'$. ref. $1'$	5
True altitude	$36^{\circ} 18'$
Comp. declin. Tab. VIII.*	1 38 N.
Latitude	$37^{\circ} 56'$ N.

EXAMPLE X.

Suppose that by a back-observation with a sextant the lower limb of the sun's image was brought to the back horizon, and the angle shown by the index was $110^{\circ} 10'$, the sun being then on the meridian and bearing south, the declination being $20^{\circ} 5'$ N. the sun's semi-diameter $16'$ and the observer 20 feet above the horizon; required the latitude?

Observed angle	$110^{\circ} 10'$
Semi-diameter.....add	16
	$110^{\circ} 26'$
Dip	sub. 4
	$110^{\circ} 22'$
Subtract.....	90 0
Zenith distance†.....	20 22 N.
Declination	20 5 N.
Latitude.....	$40^{\circ} 27'$ N.

EXAMPLE XI.

Suppose that by a back-observation with a sextant the lower limb of the sun's image was brought to the back horizon, and the angle shown by the index was $106^{\circ} 12'$, the altitude of the observer being 22 feet and the correction for semi-diameter, parallax, and dip being (as usual) about $12'$; required the true latitude, supposing the declination to be 20° S. and that the sun bore north at the time of observation?

Observed angle.....	$106^{\circ} 12'$
Dip and semi-diam.....add	12
	$106^{\circ} 24'$
Subtract . 9.....	90 0
Zenith distance†.....	16 24 S.
Sun's declination	20 0 S.
Latitude	$36^{\circ} 24'$ S.

It was observed in the directions for finding the meridian altitude of an object, that an error would arise if the ship were in motion, or the sun's declination should vary. The amount of this correction may be estimated in the following manner.

Find the number of miles and tenths of a mile *northing* or *southing* made by the ship in one hour, and also the variation of the sun's declination in an hour expressed also in miles and tenths. Add these together, if they both conspire to elevate or depress the sun, otherwise take their difference, which call the arch A. Find in Table XXXII. the arch B, expressed in seconds, corresponding to the latitude and declination; then the arch A, divided by *twice* the arch B, will express the time in *minutes from noon* when the greatest (or least) altitude was observed. Moreover, the square of the arch A, divided by five times the arch B, will be the number of *seconds* to be applied to the observed altitude to obtain the true altitude which would have been observed if the ship had been at rest.

Thus if the ship sailed towards the sun south 12 miles per hour, the declination increasing northerly $1'$ per hour, we should have $A = 11 + 1 = 12$. If the latitude was 42° N. declination 2° S. we should have by Tab. XXXII. $B = 2''$. In this case the time from noon is $\frac{1}{2}^2 = 3$ minutes, and the correction of altitude $\frac{1}{2}^4 = 12$ seconds only.

* The north polar distances of these bright stars are given for every 10 days in the Nautical Almanac; when great accuracy is required, the declinations deduced from these may be used instead of the numbers in Table VIII.

† The refraction and parallax being only a few seconds are neglected.

‡ The refraction being small is neglected.

TO FIND THE LATITUDE

BY THE

MERIDIAN ALTITUDE OF THE MOON.

THE latitude may be found at sea by the moon's meridian altitude more accurately than by any other method, except by the meridian altitude of the sun; but to do this it is necessary to find the time of her passing the meridian, and her declination at that time. To facilitate these calculations we have given the Tables XXVIII. XXIX. and XXX. The uses of which will evidently appear from the following rules and examples.

To find the true time of the moon's passing the meridian.

In the sixth page of the Nautical Almanac, find the time of the moon's coming to the meridian of Greenwich for one day earlier than the sea account;* and also the time of her coming to the meridian of Greenwich the next day, when you are in west longitude, but the preceding day when in east longitude; take the difference between these times, with which you must enter the top column of Table XXVIII. and against the ship's longitude in the side column will be a number of minutes to be applied to the time taken from the Nautical Almanac, for the day immediately preceding the sea account, by adding when in west longitude, but subtracting when in east longitude; the sum or difference will be the true time of passing the meridian of the given place.

EXAMPLE.

Required the time of the moon's passing the meridian of Philadelphia, April 19, 1820, sea account?

The day preceding the sea account is April 18, on which day the moon passed the meridian of Greenwich at 5h. 3m.; and being in west longitude, I find also the time of her passing the meridian the next day, 5h. 55m.; the difference of these two numbers is 52m.; with this I enter Table XXVIII. and at the top find 52'; under this and opposite 75° (the longitude of Philadelphia) is the correction 11', to be added to 5h. 3m.; therefore the time of passing the meridian of Philadelphia is April 19d. 5h. 14m. sea account; or April 18d. 5h. 14m. p. m. civil account.

To find the moon's declination when on the meridian.

Find the time of the moon's coming to the meridian as above; turn the ship's longitude into time, (by Table XXI.†) and add it thereto if in west longitude, but subtract it in east, the sum or difference will be the time at Greenwich.—Take out the moon's declination from page 6th of the Nautical Almanac, for the nearest noon and midnight;‡ and note the difference of the declinations if of the same name, but their sum if of different names: enter Table XXX. with this sum or difference at the top, and the time at Greenwich in the side column, under the former and opposite the latter will be the correction to be applied to the declination which stands first in the

* Taking the time one day earlier than the sea account reduces it to astronomical time used in the Nautical Almanac.

† Longitude may be turned into time without the help of Table XXI. by multiplying by 4 sexagesimally, and putting the product one denomination lower; and by dividing by 4, time may be turned into degrees, &c. Thus $90^{\circ} \times 4 = 360' = 5h. 30m.$ and $15^{\circ} 16' \times 4 = 61' 4'' = 1h. 1m. 4s.$; in like manner 1h. 20m or 80m. divided by 4, gives 20° , 3h. 16m. or 196m. divided by 4, gives 49° , which agree with the Table. If the ship be furnished with a chronometer regulated to Greenwich or mean time, this part of the operation will be saved, for by applying the equation of time, Table IV. A., with a contrary sign to that in the Table, the apparent time at Greenwich will be obtained, as in the explanation prefixed to the Tables.

‡ If the time at Greenwich be exactly noon or midnight, the true declination will be given by the Nautical Almanac, without the trouble of referring to Table XXX.

TO FIND THE LATITUDE BY THE MOON. 125

Nautical Almanac; additive, if that declination be increasing; subtractive, if decreasing; the sum or difference will be the true declination at the time of passing the meridian.

NOTES.

1. By the above rule, the day of the month on which the moon passes the meridian must be taken one less than the sea account: and when you add the longitude (turned into time) to the time of passing the meridian, and the hours of the sum exceed 24, you must subtract 24h. and add one to the day of the month; if the longitude be subtractive and greater than the time of passing the meridian, you must, previous to the subtraction, add 24 hours to the time of passing the meridian, and subtract one from the day of the month; the sum or difference will be the time at Greenwich. If this time be less than 12 hours, you must take out the declination for the preceding noon and the following midnight; but if the time exceed 12 hours, you must take out the declination for the preceding midnight and the following noon.
2. When one of the declinations taken from the Nautical Almanac is north and the other south, the difference between the correction of Table XXX. and that declination which stands first in the Nautical Almanac, will be the true declination, which will be of the same name as that first declination, when the correction of Table XXX. is less than the first declination, but if greater of a contrary name.
3. In the same manner we may find the declination for any time in the day, by making use of the given time instead of the time of the moon's passing the meridian.
4. In the above rules the second differences of the moon's motion are neglected. In cases where very great accuracy is required, the calculation may be made as in Problem I. of the Appendix.

EXAMPLE.

Required the moon's declination at the time of her passing the meridian of Philadelphia, April 19, 1820, sea account?

The time of passing the meridian of Philadelphia was found in the preceding Example to be April 19d. 5h. 14m. sea account, or April 18th. 5h. 14m. by Nautical Almanac account: this being added to the longitude of Philadelphia, in time 5h. 1m. nearly, the sum is the time at Greenwich, April 18th. 10h. 15m. The declination April 18th. at noon, was $28^{\circ} 26' N.$ and on April 18th. at midnight $27^{\circ} 48' N.$ the difference being $38'$, this being found at the top of Table XXX. and the time 10h. 15m. in the side column, the number corresponding is $33'$, which subtracted from the first declination $28^{\circ} 26'$ leaves the declination required $27^{\circ} 53' N.$

At the time of the moon's passing the meridian you must observe the altitude of her upper or lower limb, and correct this altitude for semi-diameter, dip, parallax, and refraction, and you will obtain the central altitude, with which and the declination you may find the latitude by the rules before given. Or you may correct the observed altitude by the following approximate method which shortens the calculation, and is sufficiently accurate, especially when the dip is about $4'$ or $5'$, which is nearly the value in common observations at sea.

To find the latitude by the moon's meridian altitude, obtained by a fore-observation.

To the observed altitude of the moon's lower limb add 12 minutes, but if her upper limb was observed, subtract 20 minutes; with this altitude enter Table XXIX. and take out the minutes corresponding and add thereto, the sum will be the central altitude of the moon;* with this altitude and the moon's declination found as above, the latitude may be found as by a meridian altitude of the sun.

* In calculating accurately the moon's central altitude, you must proceed in the following manner: Find the time of the moon's passing the meridian reduced to Greenwich time as above, take out the moon's horizontal parallax and semi-diameter for this time, from the seventh page of the month of the Nautical Almanac, increase the semi-diameter by the correction in Table XV. add this augmented semi-diameter to, or subtract it from the observed altitude according as the lower or upper limb was observed by a fore-observation) subtract the dip of the horizon taken from Table XIII. and add the correction for parallax and refraction (which may be easily found by Table XIX. by subtracting the correction for dip from $53' 12''$) and the sum will be the correct central altitude.

TO FIND THE LATITUDE BY THE MOON. 127

	D.	H.	M.
J passes merid. Nov.....	29	19	37
Long. 150° W. in time	10	0	

Obs. alt. J's upper limb ..	60° 26'
subtract	20

Time at Greenwich Nov.....29 5 37

	60 6
Corr. Tab. XXIX. add	28

J's decl. Nov. 29 at noon0° 27' N.
at midnight ..2 22 S.

J's corr. alt.....60 31

Sum2 49

J's zen. dist.29 26 S.

With this sum 2° 49', and the time at Greenwich 5h. 37m. I enter Table XXX.

J's declination.....0 52 S.

and find the corr. of decl.1° 19'

Latitude30 18 S.

Decl. Nov. 29 at noon.....0 27 N.

True declination0 52 S.

In this example you must refer to notes
1. and 2. page 125.



TO FIND THE LATITUDE

BY THE

MERIDIAN ALTITUDE OF A PLANET.

FROM page 4th of the month of the Nautical Almanac, take out the time of the planet's passing the meridian on the day nearest to that on which the observation was made; this will be nearly the time of passing the meridian of the place of observation.*

Turn the ship's longitude into time, and add it to the time of passing the meridian, when in west longitude, but subtract in east, the sum or difference will be the time at Greenwich nearly.† Take out the planet's declination, from the Nautical Almanac, for the times immediately preceding and following the day of observation, and note the difference of the declinations when they are of the same name, but their sum when of different names, and find the interval between these times marked in the Nautical Almanac; take also the difference between the time first marked in the Nautical Almanac and the time of observation at Greenwich (remarking that this time is one day less than the sea account;) then as the former interval of time is to the latter, so is the sum, or difference of declinations, to the correction of the declination taken first from the Nautical Almanac, additive if that declination be increasing, but subtractive if decreasing; the sum or difference will be the declination of the planet at the time of observation. But you must observe that if the correction of declination be greater than the declination first marked in the Nautical Almanac, their difference will be the sought declination, which will be of a different name from the first declination.

From the observed altitude of the planet (taken by a fore observation) subtract the refraction and dip, the latter being in general about four minutes, and the remainder subtracted from 90° will give the correct zenith distance nearly; with which, and the declination, the latitude may be found as by an observation of the sun.

* If you wish to find the time of passing the meridian more accurately, you must take a proportional part of the difference of the times of coming to the meridian given in the Nautical Almanac, in the same manner as in finding the declination of the planet.

† This time is also given by a chronometer, as in note page 124, or in the explanation prefixed to each table.

EXAMPLE.

Suppose that on the 23d October, 1820, in long. 65° W. Jupiter passed the meridian to the southward; his meridian altitude being observed was $45^{\circ} 20'$, and the dip $4'$; required the true latitude?

October 23, sea account, is October 22, by the Nautical Almanac; now on October 19, by the N. A. Jupiter passes the meridian at 9h. 26m.
To this add the long. 65° W. in time 4 20

Time at Greenwich, October 22d. 13 45
Jupiter's declination, October 19 7 39' S.
October 25 7 46 S.

Difference 7

Then say, as 6 days (which is the interval between October 19 and October 25) is to 3 days $13\frac{1}{2}$ hours (which is the time elapsed between October 19th and October 22d. $13\frac{1}{2}$ h.) so is 7 minutes to 4 minutes, which added to 7 39' S. gives $7^{\circ} 43'$ S. the true declination at the time of observation.

Jupiter's observed altitude $45^{\circ} 20'$
Subtract 4 minutes for dip and 1' for refraction 5

True altitude $45^{\circ} 15'$

Zenith distance $44^{\circ} 45'$ N.

Declination $7^{\circ} 43'$ S.

Latitude $37^{\circ} 2'$ N.



TO FIND THE LATITUDE BY DOUBLE ALTITUDES.

FORM I.—By double altitudes of the Sun.

- WHEN by reason of clouds, or from other causes, a meridian altitude cannot be obtained, the latitude may be found by two altitudes of the sun, taken at any time of the day, the interval or elapsed time between the observations being measured by a good watch or chronometer, noticing the seconds, if possible, or estimating the times to a third or a quarter of a minute, if the watch is not furnished with a second-hand. The observed altitudes of the sun must be corrected, as usual, for the semi-diameter, dip, refraction and parallax, in the same manner as in finding the latitude by a meridian altitude. When great accuracy is required, the declination must be found at the time of each observation, using the *third* method of solution hereafter given, but when the sun's declination varies slowly, or the elapsed time is small, it will in general be sufficiently accurate to find the sun's declination for the *middle time between two observations*, and to consider it as invariable during the observations, computing the latitude by the first or second method.

This manner of finding the latitude is in general most to be depended upon where the sun's meridian zenith distance is great. If the sun passes the meridian near to the zenith, much greater care must be taken in measuring the altitudes and noting the times, than would be necessary under other circumstances. The nearer the sun is to the meridian at the time of one of the observations, the more correct the result will commonly be. In general the elapsed time ought to be as great or greater than the time of the nearest observation from noon. Similar remarks may be made upon every one of the following forms.

In all these observations it is supposed that the watch moves uniformly according to *apparent* time, measuring twenty-four hours from the time of the sun's passing the meridian on two successive days at the same place of observation. If the watch gain or lose on apparent time, supposing the observer

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 129

be at rest, a correction must be applied for the gain or loss during the time elapsed between the observations, so as to obtain accurately the *elapsed time* or *hour angle*. It is not required that the watch should be regulated so as to give precisely the *hour* of observation; the only thing required is to find the *elapsed time* with all possible accuracy.

FORM II.—*Double Altitudes of a Star.*

Double altitudes of a fixed star may be used in finding the latitude, and the calculation is almost identical with that of double altitudes of the sun; the only difference consists in adding a small correction to the elapsed apparent time between the observations, on account of the daily acceleration of $3' 56''$ in the time a star comes to the meridian on successive days. This correction is obtained to a sufficient degree of accuracy by adding *one second* for every *six minutes* of the elapsed time; the sum will be the *corrected elapsed time* or *hour angle*, to be used in the calculation, either by the *first, second or third method*. Thus if the elapsed time was 3h. or 180m. the correction would be $2' 30''$ or $30''$, making the corrected elapsed time or hour angle 3h. $0' 30''$. If great accuracy is required, find the correction in Table XXXI. in the column marked at top $3' 56''$, and at the side with the elapsed time. In the preceding example, this Table would give $29''$ for the correction, instead of $30''$.

In observations of a fixed star the altitudes are to be corrected for dip and refraction, as in finding the latitude by a meridian altitude. The declination of the star is to be found in Table VIII.*. With these altitudes, the declination and the hour angle, the calculation is to be made by either of the three methods hereafter given.

The chief difficulty in observations of this kind with a fixed star is the want of a good horizon in the night time. The method, however, might sometimes be used with success, soon after the dawn of day, or late in the evening twilight, at a time when the horizon is well defined, and the star sufficiently bright to bring its reflected image to the horizon. Sometimes a good horizon is produced by the aurora borealis, in which case a good observation might be made with stars in the northern horizon, but a single observation of the polar star will answer the same purpose, and be much more simple.

FORM III.—*Double Altitudes of a Planet.*

Double altitudes of a planet (particularly Jupiter and Venus, on account of their great brightness) might sometimes be used with success. The observed altitudes must be corrected for dip and refraction. The parallax and semi-diameter being small may be neglected, except in cases where extreme accuracy is required. The declination of the planet is to be found in page IV. of the Nautical Almanac, for the supposed time at Greenwich. The daily variation of the time of coming to the meridian is also to be found in the same page where the hour is marked at intervals of 6 days, and thus the time elapsed between the passage of the planet over the meridian on two successive days is found; then the corrected elapsed time or *hour angle* is obtained by the following

RULE. As the interval of time between two successive passages of the object over the meridian is to 24 hours, so is the apparent elapsed time between the observations, to the corrected elapsed time or hour angle: Or more simply by means of Table XXXI. finding the daily variation in the time of coming to the meridian at the top† and the elapsed time at the side, the corresponding correction is to be *added* to the elapsed time when the time of coming to the meridian is *earlier* on successive days, as is generally the case, but *subtracted* if *later*, the sum or difference will be the corrected elapsed time or hour angle nearly.

With this *hour angle*, the *declination* and *corrected altitudes*, the latitude may be found by either of the three following methods of calculation.

* Or more accurately in the Nautical Almanac, if any one of the twenty-four bright stars is observed, whose place is given in that work.

† If the daily variation be less than 3 1-2 minutes, which is the smallest in the table, you may multiply the daily variation by 2 or 3, &c. and divide the result by the same number, and the correction will be obtained.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 131

two minutes, the half sum of the two altitudes of the first object may be taken for the altitude corresponding to the time of observing the second altitude, and the calculation may then be made as in Form V. Thus, suppose at 10h. 2m. A. M. per watch, the altitude of Sirius was $17^{\circ} 54'$, at 10h. 4m. per watch the altitude of Capella $60^{\circ} 45'$, and at 10h. 6m. per watch the altitude of Sirius was again observed and found to be $17^{\circ} 58'$. In this case the intervals of time are exactly two minutes, therefore the half sum of the altitudes of Sirius is to be taken $17^{\circ} 56'$, and combined with the altitude of Capella $60^{\circ} 45'$, supposing *both* to have been observed at 10h. 4m. per watch. This is the most simple form in which an observation of this kind can be made by one observer.

If, from any cause whatever, the observations cannot be taken at exactly equal intervals, the altitude of the first object, at the time of observing the second object, may be found by proportion, supposing the altitudes to vary uniformly during the few minutes of the observations. Thus in the preceding example, suppose the altitudes and the two first noted times to remain unaltered, but the last observation of Sirius to have been at 10h. 10m. per watch, (instead of 10h. 6m.) In this case, during the 3 minutes of time elapsed between 10h. 2m. and 10h. 10m. Sirius would have risen $4'$ (from $17^{\circ} 54'$ to $17^{\circ} 58'$), therefore, by proportion, it is found that in 2 minutes (the time elapsed between 10h. 2m. and 10h. 4m.) the star would have risen $1'$, and the altitude would have increased from $17^{\circ} 54'$ to $17^{\circ} 55'$: therefore at the time 10h. 4m. per watch, the altitude of Sirius must be taken at $17^{\circ} 55'$, the altitude of Capella $60^{\circ} 45'$, and with these quantities considered as observed at this last mentioned time 10h. 4m. the calculation must be made as in Form V.

There are several advantages attending these two last Forms V. VI. since no allowance is necessary for the change of place of the ship; the observations can be immediately made, in a short interval of fair weather, when the common method of double altitudes might fail from the intervention of clouds; the time can also be obtained at the same operation, &c.

FORM VII.—*By altitudes of two different objects, taken at different times.*

This method differs but very little from the two last: the altitudes are to be corrected in the same manner for dip and refraction, also for parallax and semi-diameter when necessary. The right ascension and declination of *each* object is to be found for the supposed time of observing *that* object reduced to the meridian of Greenwich. Then the apparent elapsed time between the observations, is to be turned into sidereal time, which may be done with sufficient accuracy as in the Form II. by adding *one second* for every *six minutes* of the elapsed time, the time thus corrected is to be added to the right ascension of the body first observed: the difference between this sum and the right ascension of the body last observed is the *hour angle*.^{*} This, with the declinations and corrected altitudes, are to be used in finding the latitude by the *third* of the following methods of calculation, it being very rarely the case that the first or second methods can be used on account of the difference of the declinations. These three last forms, when a fixed star or planet is used, are restricted very much from the want of a good horizon in the night; they are best adapted to the morning and evening twilight.

GENERAL REMARKS.

Having thus explained several of the different *forms* of making these observations, and the manner of finding in each form the *hour angle*, the *declinations* and the *correct central altitudes*, we shall now give three different methods of calculating the latitude, and shall illustrate the rules by proper examples. In the *first* and *second* methods the declination is supposed to be the *same* at both observations, which is true as it respects observations of a fixed star, and is in general sufficiently correct for common observations of double altitudes of the sun. The first of these methods is direct and simple, not embarrassed with much variety of cases, requiring only ten openings of the Table XXVII. without any halving or doubling of the logarithms, or the use

^{*} If this difference exceed 12 hours, subtract it from 24 hours, and use the remainder as in Form I.

132 TO FIND THE LATITUDE BY DOUBLE ALTITUDES.

of natural or versed sines. This method is in fact nearly, if not fully, as short as the *second* or approximative method invented by Mr. Douwes, and which was exclusively used in the former editions of this work. This second, or Douwes' method, is liable to the objection, that the calculation must sometimes be repeated several times before a true solution can be obtained, and then it becomes extremely troublesome. This difficulty does not occur in the first method, and on this account, as well as for its remarkable simplicity, it is always to be preferred.

The *third* method embraces the general solution of the problem in the case where the variation of declination is noticed. This increases the labour considerably, and renders the solution more complex in its cases. It is, however, believed, that this method (drawn up in its present form by the author of this work) will be easily understood by navigators, and that they will thus be enabled to determine the latitude with considerable accuracy in cases where it might be of the utmost importance to know it, and where other methods could not be resorted to on account of bad weather. This method is nearly, if not quite, as short as that published by Dr. Brinkley in the Nautical Almanac of 1825, and does not require, like his method, a second or third, or even a greater number of operations.

If the observer should change his place or station during the elapsed time between the observations, a correction must be applied to one of the altitudes on this account. The manner of doing this is shown in the following examples V. and VI.

It may be observed, that in like manner as there are two latitudes corresponding to the *same* meridian altitude of the sun, according as the zenith is north or south of the sun when on the meridian; so in double altitudes there are generally two latitudes, corresponding to the proposed altitudes, according as the zenith and north pole are on the same side or on different sides of the *arc* or *great circle* passing through the two observed bodies, or through the two places of the same body; and it therefore becomes necessary to notice (at the time of observation) how the zenith and north pole are situated with respect to this great circle.

To estimate the effect of small errors in the observations.

When running in with the land, or crossing a dangerous parallel with no other means of obtaining the latitude than by double altitudes, it becomes a matter of great importance to ascertain the possible error of the latitude thus computed, arising from supposed errors in the observed altitudes, or in the elapsed time. The differential expressions in spherical trigonometry afford methods of doing this, but they are not adapted to the nature of this work, on account of the complication and variety of cases. The following method, though long, is general and infallible, and was once used by the writer in a case of great anxiety and danger.

RULE. After having computed the latitude by either of the three following methods, using the observed altitudes* and elapsed time, *repeat the operation*, varying the altitude you suspect may be erroneous by 2' or 3', (whatever you suppose the limit of the error in that altitude may be) the difference between this *second* latitude and that first computed, is the effect of the supposed error in that altitude. If you suspect the second altitude also to be erroneous, the operation may be again repeated, varying this second altitude 2' or 3' (or whatever the limit may be supposed) but using the first observed altitude and elapsed time, comparing this *third* computed latitude with the *first*, the difference is the effect of this supposed error in the second altitude. Finally, if the elapsed time is supposed to be erroneous, the operation may be again repeated, using the observed altitudes and varying the elapsed time by 20 or 30 seconds (or whatever the limit of this error may be supposed) the difference between this *fourth* latitude and that *first* computed is the effect of this supposed error of the elapsed time.

Thus, suppose the first computed latitude was 30° , the second $30^{\circ} 1'$, the

* Meaning the observed altitudes, corrected as usual for dip, refraction, parallax and semi-diameter, as necessary.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 133

third $30^{\circ} 5'$, the fourth $30^{\circ} 2'$. The error arising from the first altitude would be $1'$, that from the second altitude $3'$ and that from the elapsed time $2'$. If all these errors existed at the same time, the greatest limit of the error would be the sum of these quantities or $6'$, so that the true latitude would be $30^{\circ} \pm 6'$ or between $29^{\circ} 54'$ and $30^{\circ} 6'$. In this way the limit of the error may be obtained in any case, and the degree of confidence that may be placed in the observation obtained. This examination is sometimes very necessary, because the objects may be so situated, that a small error in the observations might produce a considerable change in the computed latitude. It may be observed that the error of one observation is frequently corrected in whole or in part, by the error of the other; the one tending to increase the latitude, the other to decrease it.

To find the Latitude by Double Altitudes of the Sun (or any other object) the declination being invariable.

FIRST METHOD.

In this method the log-sines, co-sines, &c. of Table XXVII. are used. and for brevity the word log. is omitted in the rule. For the convenience of writing down at once in the same line all the logarithms which occur at the same opening of the book, they are arranged in three columns, as in the following formula, and it will be very convenient to have one of these blanks prepared at the commencement of the operation, and then the logarithms may be written down in their proper places with great rapidity.

FORMULA.

Col. 1.	Col. 2.	Col. 3.
Elapsed time [P.M.] co-sec.		
Declination .....sec.	.....co-sec.	
A .....co-sec.	co-sine	.....co-sine
$\frac{1}{2}$ sum alts. ....co-sine	co-sec.	B co-sec.
$\frac{1}{2}$ diff. alts. ....sine	sec.	[B less than 90° , like decl. N. or S.]
C .....sine	co-sine	.....co-sine
Z [Less than 90° , north or south like bearing of Zenith.]		Z
[E is Sum of R, Z, of same name, difference: if of different name.]		E sine
	Latitude..	sine

RULE. (Using Table XXVII.)

1. Find the elapsed time* in column P. M. take out the corresponding co-secant and put it in Col. 1.
2. Put the secant of the declination in Col. 1, its co-secant in Col. 3.
3. The sum of the logarithms in Col. 1, (rejecting 10 in the index) is the co-secant of the angle A, whose co-sine is to be put in Col. 2 and Col. 3.†
4. The sum of the logarithms in Col. 3, (rejecting 10 in the index) is the co-secant of the angle B (less than 90°) which is to be named *north* or *south*, like the declination.
5. Find half the sum of the two altitudes; place its co-sine in Col. 1, its co-secant in Col. 2. Find also half the difference of the two altitudes; place its sine in Col. 1, its secant in Col. 2.
6. The sum of the three lower logarithms of Col. 1, (rejecting 20 in the index) is the sine of the angle C, whose co-sine is to be placed in Col. 2, and Col. 3.†
7. The sum of the logarithms in Col. 2, (rejecting 30 in the index) is the secant of the zenith angle Z, which is to be taken out (less than 90°) and placed under B in Col. 3, naming it *north* if the zenith and north pole be

* If any other object than the sun is observed, the corrected elapsed time or hour angle, found as before taught, is to be used.

† The co-sines of A and C are each written down twice, which reduces the number of logarithms in each example from 17 to 15.

134 TO FIND THE LATITUDE BY DOUBLE ALTITUDES.

situated on the *same* side of the arch or great circle passing through the two observed places (or objects), but *south* if the zenith and north pole be situated on *different* sides of that great circle.*

8. The angle E is found by taking the *sum* of the angles B, Z, if they are of the *same* name, or their *difference* if of *different* names, marking E *north* or *south*, like the greatest of the two angles B or Z.†

9. Put the sine of E in Col. 3. and the sum of the two last written logarithms of Col. 3. (rejecting 10 in the index) is the sine of the latitude, of the same name as E.

If the time of observation were required, it might be found by the following rule (still using Table XXVII.)

RULE.—Add the tangent of C to the secant of E, the sum (rejecting 10 in the index) is the tangent of an angle. Take out half the corresponding time in Col. P. M. (or in Col. A. M. increased by 12 hours) and this will represent the horary distance of the object from the meridian, (upper or lower) at the middle time between the two observations. Take the sum and difference between this and half the elapsed time, or hour angle, and they will be the hours and minutes distance from the meridian corresponding to both observations, expressed in apparent solar time if the sun be observed, sidereal time if a star is observed, &c.

EXAMPLE I.

Being at sea in latitude 46° 30' N. by account, when the sun's declination was 11° 17' N. at 10h. 2m. per watch, in the forenoon, the sun's correct central altitude was 48° 55', and at 11h. 27m. per watch, in the forenoon the correct central altitude was 54° 9'. Required the true latitude?

Subtracting 10h. 2m. from 11h. 27m. gives the elapsed time 1h. 25m.

Col. 1.	Col. 2.	Col. 3.
Elap. time [P.M.] 1h.25m. co-sec. 10.73430		
Declination 11° 17' N. ..sec. 10.00848	.....	co-sec. 10.70854
A .....co-sec. 10.74278	co-sine 9.99278	..... co-sine 9.99278
½ sum alts. 50 32 .....co-sine 9.80320	co-sec. 10.11239	B 11° 28' N. co-sec. 10.70126
½ diff. alts. 3 37 .....sine 8.79970	sec. 10.00087	[B less than 90°, name N. or S. like decl.]
C .....sine 9.34568	co-sine 9.93907	..... co-sine 9.98907
Z [Less than 90° and N. or S. like bearing of Zenith.]	sec. 10.09511	Z 36 33 N.
[E is sum of B, Z, if of same name, difference if of different name.]		E 48 01 N. sine... 9.87119
		Latitude 46 27 N. sine... 9.86026

If the sun had passed the meridian to the north of the observer, Z would have been 36° 33' S. and E. 25° 5' S. whose sine 9.62730 added to cos. C 9.98907 gives the sine of the latitude 9.61637, corresponding to 24° 25' S.

In the first case (in north latitude) the tangent of C 9.35640 added to the secant E 10.17463 gives 9.53103, which, in the tangents, corresponds to 2h. 30m. nearly, whose half 1h. 15m. is the time of the middle observation from noon; adding and subtracting half the elapsed time 42m. 30s. gives the times from noon 1h. 57m. 30s. and 0h. 32m. 30s. of the observations, a small difference would be found if the calculation had been made to seconds instead of the nearest minute.

EXAMPLE II.

At sea in the latitude of 47° 19' N. by account, when the sun's declination was 12° 16' N. at 10h. 24m. A. M. per watch, the sun's correct central alti-

* In observations of the sun the angle Z may in general be called *north*, if the zenith be *north* of the sun when on the meridian at its greatest altitude, but *south* if the zenith be then *south* of the sun. When the object passes the meridian near the zenith, it may be doubtful whether it be *north* or *south* in which case the latitude may be computed upon both suppositions, and that one selected which agree best with the estimated place of the ship, and this extra labour is very small. But observations on an object passing near the zenith, are liable to great errors, and had better be rejected.
† This case is easily remembered, because s is the first letter of *same* and *sum*, and d the first letter of *different* and *difference*.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 133

side was $49^{\circ} 9'$, at 1h. 14m. P. M. per watch, his correct central altitude was $1^{\circ} 59'$. Required the latitude?

Subtracting 10h. 24m. from 1h. 14m. increased by 12h. leaves the elapsed time 2h. 50m.

COL. 1.	COL. 2.	COL. 3.
Elap. time [P.M.] 2h. 50m. co-sec. 10.44077		
Declination $12^{\circ} 16' N.$..sec. 10.01003	.....	co-sec. 0.67272
A .....co-sec. 10.45080	co-sine 9.97087	..... co-sine 9.97087
sun. alts. 50 34 .....co-sine 9.80290	co-sec. 10.11218	B $13^{\circ} 08' N.$ co-sec. 10.64359
diff. alts. 1 25 .....sine 8.39310	sec. 10.00013	[B less than 90° , named N. or S. like decl.]
C .....sine 8.64690	co-sine 9.99958	..... co-sine 9.99958
Z [Less than 90° and N. or S. like bearing of Zenith.]	sec. 10.08276	Z 34 16 N.
[E is sum of B, Z, if of same name, difference if of different name.]		E 47 24 N. sine... 9.86694
		Latitude 47 20 N. sine... 9.86652

If the sun had passed the meridian to the north of the observer, Z would have been $34^{\circ} 16' S.$ E. $21^{\circ} 08' S.$ its sine 9.55695 added to cos. C 9.99958 gives 9.55653, the sine of the latitude $21^{\circ} 7' S.$

If the observed object in this example had been a fixed star, with the same declination $12^{\circ} 16' N.$ the same altitudes $49^{\circ} 9'$, $51^{\circ} 59'$, but the elapsed time 2h. 49m. 32s., the calculation would have been exactly as above. For by adding, according to the rule heretofore given, one second for every six minutes of elapsed time, which in this case would be 28 seconds, the corrected elapsed time would be 2h. 50m. and every part of the work would be as above.

If the planet Mars had been observed, at the same corrected altitudes, on the 19th June, 1820, in a place where his declination at the middle time between the two observations was, by the Nautical Almanac, $12^{\circ} 16' N.$ and the elapsed time 2h. 49m. 46s. the calculation would still be the same. For, by the Nautical Almanac, it appears that Mars passes the meridian on the 19th and 25th of June, at 4h. 21m. and 4h. 9m. accelerating 2 minutes per day. This being less than the numbers in Table XXXI. is to be doubled (as in note to Form III.) and the elapsed time being found at the side, the corresponding correction 28" halved and added to the elapsed time 2h. 49m. 46s. gives the hour angle 2h. 50m. to be used as above, all the work being the same. Proceed in like manner if the moon was observed at a time when the declination varies but little.

EXAMPLE III.

Being at sea, in latitude $50^{\circ} 40' N.$ by account, when the sun's declination was $20^{\circ} 0' S.$ at 10h. 17m. A. M. per watch, the sun's correct central altitude was found to be $17^{\circ} 15'$, at 11h. 17m. per watch, the correct central altitude was found to be $19^{\circ} 41'$. Required the latitude?

Subtracting 10h. 17m. from 11h. 17m. gives the elapsed time 1h.

COL. 1.	COL. 2.	COL. 3.
Elap. ti. [P.M.] 1h. 0m. co-sec. 10.88430		
Declination $20^{\circ} 0' S.$..sec. .. 10.02701	.....	co-sec. 10.46595
A .....co-sec. 10.91131	co-sine 9.99670	..... co-sine 9.99670
sun alts. 18 27 ... co-sine 9.97708	co-sec. 10.49966	B $20^{\circ} 10' S.$ co-sec. 10.46265
diff. alts. 1 14 .....sine.. 8.33292	sec. .. 10.00010	[B less than 90° named N. or S. like dec.]
C .....sine.. 9.22131	co-sine 9.99390	..... co-sine 9.99390
Z [Less than 90° and N. or S. like bearing of Zenith.]	sec. .. 10.49036	Z 71 8 N.
[E is sum of B, Z, of same name, difference of different name.]		E 50 58 N. sine.. 9.89030
		Latitude 50 00 N. sine.. 9.88420

136 TO FIND THE LATITUDE BY DOUBLE ALTITUDES

If the sun had passed the meridian to the north of the observer, Z would have been $71^{\circ} 03' S.$ and E $91^{\circ} 18' S.$ whose sine 9.99989 added to 8.99330 gives the sine of the latitude 9.99379, corresponding to $80^{\circ} 20' S.$

EXAMPLE IV.

Being at sea in the latitude of $60^{\circ} 0' N.$ by account, when the sun was on the equator (or had no declination) at 1h. 0m. P. M. per watch, his correct central altitude was $28^{\circ} 53'$, and at 3h. 0m. P. M. per watch, the correct central altitude was $20^{\circ} 42'.$ Required the true latitude?

Col. 1.	Col. 2.	Col. 3.
Elap. time [P. M.] 2h. 0m. co-sec. 10.58700		
Declination 0..... sec. 10.00000	.....	[co-sec. Infinite]
A..... $30^{\circ} 0'$ co-sec. 10.58700	co-sine 9.98494	..... [co-sine 9.98494]
$\frac{1}{2}$ sum. alts. .. $24\ 47\frac{1}{2}$ co-sine 9.95801	co-sec. 10.37745	B $0^{\circ} 0'$ [co-sec. Infinite]
$\frac{1}{2}$ diff. alts. ... $4\ 5\frac{1}{2}$ sine .. 8.85340	sec. .. 10.00110	[B less than 90° named N. or like dec.]
C..... sine .. 9.39841	co-sine 9.98594	..... co-sine 9.98594
Z [Less than 90° , and N. or S. like bearing of Zenith.]	sec. .. 10.34943	Z $63^{\circ} 26' N.$
[E is sum of B, Z, if of same name, difference of diff. name]		E $63\ 26\ N.$ sine 9.95154

Latitude $59\ 59\ N.$ sine 9.93748

The calculations would have been the same for south latitude, which would be $59^{\circ} 59' S.$ The computation of A and B might have been dispensed with, for when the declination is nothing, B is nothing, and A is equal to the elapsed time 2h. turned into degrees by Table XXI. being in this example 30° ; in this case all the terms included between the brackets [] might be omitted.

In the preceding examples both altitudes were supposed to be taken at the same place or station; but as that is seldom the case at sea, the necessary correction for any change of place must be made in the following manner.

Let the bearing of the sun be observed by the compass at the instant of the first observation; take the number of points between that bearing and the ship's course, corrected for lee-way, if she makes any; with which, if less than eight, or with what it wants of 16 points, if more than eight, enter the traverse table, and take out the difference of latitude corresponding to the distance run between the observations. Add this difference of latitude to the first altitude, if the number of points between the sun's bearing and the ship's course were less than eight: but subtract the difference of latitude from the first altitude, if the number of points were more than eight, and that altitude will be reduced to what it would have been if observed at the same place where the second was.* This corrected altitude is to be used with the second observed altitude in finding the latitude by the above rule. The latitude resulting will be that of the ship at the time of taking the second altitude, and must be reduced to noon by means of the log.

EXAMPLE V.

In a ship running N. by E. $\frac{1}{2}$ E. per compass, at the rate of 9 knots per hour, at 10h. 0m. A. M. per watch, the sun's correct central altitude was found to be $13^{\circ} 18'$ bearing S. $\frac{1}{2}$ E by compass, and at 1h. 40m. P. M. per watch, the sun's central altitude was found to be $14^{\circ} 15'$, the latitude by account being $49^{\circ} 17' N.$ and the sun's declination $23^{\circ} 28' S.$ Required the true latitude?

* This is the only correction necessary to make full allowance for the run of the ship; and the unexperienced calculator must take care not to fall into the error of applying a correction to the elapsed time, as is directed in several works of note, particularly in the "Complete Navigator," by Dr. Blackav. This will appear evident by supposing in the above Example V. that a second observer, with a watch regulated exactly like that used by the first, was at rest at the place of the second observation. Then at the first observation at the same moment of time by both watches, the first observer would find the sun's altitude $13^{\circ} 18'$, and the second observer $12^{\circ} 49'$. At the second observation the times and altitudes would be alike, so that the elapsed time found by both observers would be the same, and the observations would require no correction, except what arises from reducing the altitude from $13^{\circ} 18'$ to $12^{\circ} 49'$, because the second observer is supposed to be at rest, and his observation requires no correction.

The correction to the first altitude.

The time elapsed between the observations was 3h. 40m. and in that time the ship sailed 33 miles upon the course N. by E. $\frac{1}{2}$ E. which makes an angle of $13\frac{1}{2}$ points with the sun's bearing at the first observation S. $\frac{1}{2}$ E. the complement of which to 16 points is $2\frac{1}{2}$ points. Now in Table I. the course $2\frac{1}{2}$ points, and distance 33m. give 29 miles difference of latitude, which must be subtracted from the first altitude $13^{\circ} 18'$ because the ship sailed above 8 points from the sun; therefore the first altitude corrected will be $12^{\circ} 49'$, which must be used in the rest of the work.

Col. 1.	Col. 2.	Col. 3.
Elap. time [P.M.] 3h. 40m. co-sec. 10.33559		
Declination $23^{\circ} 28'$ S. sec. .. 10.03749		co-sec. 10.39988
A co-sec. 10.37308	co-sine 9.95704	co-sine 9.95704
$\frac{1}{2}$ sun alts. 13 32 ... co-sine 9.98777	co-sec. 10.63076	B $26^{\circ} 05'$ S. co-sec. 10.35692
$\frac{1}{2}$ diff alts. 0 43 ... sine .. 8.09718	sec. .. 10.00003	[B less than 90° and named N. or S. like declination.]
C sine .. 8.45803	co-sine 9.99982	co-sine 9.99982
Z [Less than 90° and N. or S. like bearing of Zenith.]	Z sec. 10.58765	Z 75 01 N.
[E is sum of B, Z, if of same name, difference if of different name.]		E 48 56 N. sine .. 9.87734
	Latitude 48 54 N. sine .. 9.87716	

If the sun had passed the meridian to the north of the observer, Z would have been $75^{\circ} 01'$ S. and E $101^{\circ} 06'$ S. whose sine 9.99180 added to 9.99982 gives the sine of the latitude 9.99162 corresponding to $78^{\circ} 47'$ S.

EXAMPLE VI.

Sailing N. E. $\frac{1}{2}$ E. by compass, at the rate of 9 knots an hour, at 0h. 31' 40" P. M. per watch, the altitude of the sun's lower limb, was $28^{\circ} 20'$ above the horizon of the sea, the eye being elevated 20 feet above the surface of the water, and the sun's bearing by compass S. by W. and at 2h. 58m. 20s. P. M. by watch, the altitude of the sun's lower limb was $16^{\circ} 41'$ above the horizon, the eye being elevated as before, the latitude by account, at the time of the last observation, $48^{\circ} 0'$ north, and the declination $13^{\circ} 17'$ south. Required the true latitude at taking the last observation?

The correction of these altitudes for semi-diameter, parallax and dip, was 12 miles additive, which makes them $28^{\circ} 32'$ and $16^{\circ} 53'$; the refraction corresponding to the first was 2 miles, and for the second 3 miles, by subtracting which we have the true central altitudes $28^{\circ} 30'$ and $16^{\circ} 50'$. Now the elapsed time between the observations was 2h. 26m. 40s. during which the ship sailed 22 miles (at 9 miles per hour) in the direction of N. E. $\frac{1}{2}$ E. per compass, the bearing of the sun at the first observation S. by W. being $12\frac{1}{2}$ points distant from the ship's course, and as $12\frac{1}{2}$ points want $3\frac{1}{2}$ of 16 points, I enter Table I. and find the course $3\frac{1}{2}$ points and distance 22, corresponding to which in the latitude column is 17 miles, which subtracted from the first altitude $28^{\circ} 30'$ leaves the corrected first altitude $28^{\circ} 13'$; with this and the second altitude $16^{\circ} 50'$, I calculate the latitude in the following manner:

Col. 1.	Col. 2.	Col. 3.
Elap. ti [P.M.] 2h. 26' 40" co-sec. 10.50232		
Declination $13^{\circ} 17'$ S. sec. .. 10.01178		co-sec. 10.63871
A co-sec. 10.51410	co-sine 9.97861	co-sine 9.97861
$\frac{1}{2}$ sun alts. 22 $31\frac{1}{2}$.. co-sine 9.96553	co-sec. 10.41670	B $13^{\circ} 58'$ S. co-sec. 10.61732
$\frac{1}{2}$ diff alts. 5 $41\frac{1}{2}$.. sine 8.99643	sec. 10.00215	[B less than 90° , and named N. or S. like decl.]
C sine 9.47603	co-sine 9.97962	co-sine 9.97962
Z [Less than 90° , and N. or S. like bearing of Zenith.]	Z sec. 10.37708	Z 65 11 N.
[E is sum of B, Z, if of same name, difference if of diff. name.]		E 51 13 N. sine 9.89183
	Latitude 48 03 N. sine 9.87145	

If the sun had passed the meridian to the north of the observer, Z would have been $65^{\circ} 11'$ S. and E $79^{\circ} 09'$ S. whose sine 9.99217 added to co-sine of C 9.97962 gives the sine of the latitude 9.97179, corresponding to $69^{\circ} 31'$ S.

138 TO FIND THE LATITUDE BY DOUBLE ALTITUDES.

EXAMPLE VII.—(Same as *Dr. Brinkley's Nautical Almanac* for 18

The latitude by account $6^{\circ} 30'$ N. sun's declination $5^{\circ} 30'$ N. the correct central altitudes were found to be $35^{\circ} 21'$ and $70^{\circ} 01'$, with an elap time between the observations of 2h. 20'. Required the latitude, the passing the meridian south of the observer?

Elap. time [r.m.] 2h. 20m. co-sec. 10.52186					
Declination $5^{\circ} 30'$ N. sec. .. 10.00200	.....	.....	co-sec. 11.0		
A..... co-sec. 10.52386	co-sine 9.97962	.....	co-sine 9.9		
$\frac{1}{2}$ sum alts. 52 41 co-sine 9.78263	co-sec. 10.09947	B $5^{\circ} 46'$ N. co-sec. 10.9			
$\frac{1}{2}$ diff. alts. 17 20 sine .. 9.47411	sec. .. 10.02018	[B less than 90° , N. or S. like			
C..... sine .. 9.78060	co-sine 9.90170	..... co-sine 9.9			
Z [Less than 90° , and N. or S. like bearing of Zenith.]	Z sec. 10.00097	Z 3 50 N.			
[E is sum of B, Z, if of same name, difference if of diff. name.]		E 9 36 N. sine .. 9.1			
	Latitude 7 38 N. sine .. 9.1				

If the sun had passed to the meridian *north* of the observer, Z would have been $3^{\circ} 50'$ S. and $E = 1^{\circ} 56'$ N. whose sine 8.52810 added to the co-sine 9.90170 is 8.42980, which is the sine of the other latitude $1^{\circ} 32'$ N. so in this example both latitudes are *north*.

SECOND METHOD

of finding the latitude by double altitudes of the sun, when the variation of declination is neglected.

This method of finding the latitude depends on a set of tables, marked XXIII. in this collection, first prepared by Mr. Douwes, containing the logarithms titled Half Elapsed time, Middle time, and Log. rising. The former are arranged together as far as six hours, the latter is placed at the end of the table, and is extended in the present edition as far as 12 hours. The table with the proper title must be entered at the top with the hour, at the side with the minute, and in the column marked at the top with the seconds the corresponding number will be the sought logarithm, to which must be prefixed the index of the log. under 0" in the same horizontal line. To the time 3h. 52' 10" correspond the log. half-elapsed time 0.07138, middle time 5.22985, and log. rising 4.67274. In general it will be sufficiently exact to take these logarithms to the nearest 10 seconds, particularly when the sun's zenith distance is great; but if the log. to the nearest second is required, it may be found by taking the difference of the tabular logarithms corresponding to the next greater and next less time, and saying as 10" that difference, so are the odd seconds of time to the correction of the tabular logarithm, additive, if increasing, subtractive, if decreasing. Thus the log. $\frac{1}{2}$ El. time corresponding to 3h. 52' 18" were required: the logs. corresponding to 3h. 52' 10" and 3h. 52' 20" are 0.07138 and 0.07119, whose difference is 19, then $10'' : 19 :: 8'' : 15$.—This subtracted from 0.07138 leaves 0.07123, the sought logarithm. By inverting the process we may find the nearest second corresponding to any given logarithm. We shall now give the rule for calculating the latitude adapted to double altitudes of the sun.

RULE.

To the log. secant of the latitude by account (Table XXVII.) add the log. secant of the sun's declination (Table XXVII.) rejecting 10 in each in the sum is to be called the log. ratio.

From the natural sine of the greatest altitude (Table XXIV.) subtract the natural sine of the least altitude (Table XXIV.) find the logarithm* of the difference (in Table XXVI.) and place it under the log. ratio.

Subtract the time of taking the first observation from the time of taking the second, having previously increased the latter by 12 hours when the observations are on different sides of noon by the watch; take half the remainder, which call half the elapsed time.

With half the elapsed time enter Table XXIII. and from the column half elapsed time take out the logarithm answering thereto, and write it under the log. ratio.

* The index of this logarithm being as usual one less than the number of figures contained in the difference of those natural sines. You must also observe that the altitudes to be used are the central altitudes: that is, the observed altitudes corrected for dip, semi-diameter, parallax and refraction.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 139

Add these three logarithms together, and with their sum enter Table XXIII. In the column of middle time, where, having found the logarithm nearest hereto, take out the time corresponding, and put it under half the elapsed time. The difference between these times will be the time from noon when the greater altitude was taken.

With this time enter Table XXIII and from the column of log. rising, take out the logarithm corresponding, from which logarithm subtract the log. ratio, the remainder will be the logarithm of a natural number, which being found in Table XXVI,* and added to the natural sine of the greater altitude, will give the natural co-sine of the sun's meridian zenith distance, which may be found in Table XXIV. Hence the latitude may be obtained by the rules of page 121.

NOTES.

1. If the computed latitude should differ considerably from the latitude by account, it will be proper to repeat the operation, using the latitude last found instead of the latitude by account, till the result gives a latitude nearly agreeing with the latitude used in the computation.

2. This method is best suited to situations where the sun's meridian zenith distance is not much less than half the latitude, for in latitudes where the sun approaches near to the zenith, the observations must be taken much nearer to noon, and the preceding rule, instead of approximating, will in some cases give the results of successive operations, wider and wider from the truth. To remedy this difficulty, a set of tables was published by Dr. Brinkley, at the end of the Nautical Almanac for 1799, but the great variety of cases incident to his method will hinder it from being generally used. Instead of Dr. Brinkley's method, we may generally use the method of arithmetical computation, called *Double Position*, which will frequently give, in a more simple manner, the required latitude, as will be shown in Example X and in general it may be observed, that where Douwes' rule does not approximate, the object is most commonly so situated, as not to furnish the necessary observations to obtain a correct latitude, whatever method of computation might be used.

3. The operation is the same whether the sun has north or south declination, and also whether the ship is in north or south latitude. When the sun has no declination, the log. secant of the latitude (rejecting 10 in the index) will be the log. ratio and when the latitude by account is nothing, the secant of the declination (rejecting 10 in the index) will be the log. ratio. This rule, as well as the former, is founded on the supposition that the declination is taken for the middle time between the observations, and that it does not vary during the elapsed time, which, however, rarely happens, and a correction ought to be applied to the latitude on this account, but this correction is generally small, and if it is large, the third method must be used, or the new method in the Appendix of this work.

EXAMPLE VIII.—(Same as Example I. preceding.)

Being at sea in latitude $46^{\circ} 30'$ N. by account, when the sun's declination was $11^{\circ} 17'$ N. at 10h. 2m. in the forenoon, the sun's correct central altitude was $46^{\circ} 55'$, and at 11h. 27m. in the forenoon, his correct central altitude was $54^{\circ} 9'$. Required the true latitude, and true time of the day when the greater altitude was taken?

Times.					
	H. M. S.	Alt.	Nat. Si.	Lat. by acc. ...	46° 30' Sec. 0.16219
1 obs.	11 27 0	54° 9'	91055	Dec.	11 17 Sec. 0.00848
2 obs.	10 2 0	46 55	73036	Log. ratio	0.17067
Elap. time	1 25 0	Diff. Nat. Sines	8019	Log. Diff. Nat. Sines	3.90412
1/2 Elap. time	0 42 30			Log. 1/2 Elap. time	0.73429
		H. M. S.			
Middle time		1 15 10		4.80908	
1/2 Elap. time		42 30			
2 Obs. from noon		0 32 40		Its log. rising	3.00608
				Log. ratio sub.	0.17067
Nat. numb.			685	corresponding to log.	2.93541
Nat. sine greatest alt.			91055		
Sum is nat. co-sine ☉'s zen. dist.		81740		equal to	35° 10' N
☉'s declination					11 17 N.
Latitude in					46 27 N.

* Taking as usual a primitive of figures equal to the index of that logarithm increased by unity.

140 TO FIND THE LATITUDE BY DOUBLE ALTITUDES:

The latitude $46^{\circ} 27'$ differing only $3'$ from the latitude by account, may be assumed as the true latitude.

By means of the time of the second observation from noon above found $32' 40''$, the error of the watch may be found; for in the present example, by subtracting $32' 40''$ from $12h$. we have the time of the second observation $11h. 27' 20''$; but the time of the watch was $11h. 27' 0''$; therefore the watch was 20 seconds too slow; a small difference would be found in these numbers, if we were to proportion the logarithms of Tab. XXIII. to seconds. In the same manner the error of the watch may be found in the following examples.*

EXAMPLE IX.—(Same as Example V. before given.)

In this example the latitude by account was $49^{\circ} 17' N$. The sun's declination $23^{\circ} 28' S$. The first altitude corrected as before taught $12^{\circ} 46'$, the second altitude $14^{\circ} 15'$. From which the true latitude is required?

	H.	M.	S.	Alt.	Nat. Si.	Lat. by acc.		Sec.
2 Obser.	13	40	0	$14^{\circ} 15' = 24615$		Declination	$23 \ 28$	0.19554
1 Obser.	10	0	0	$12 \ 49 = 22183$				0.03749
Elap. time	3	40	0	Diff. nat. si.	2432	Log. ratio		0.22303
$\frac{1}{2}$ Elap. time	1	50	0			Its log.		3.38596
	0	10	10	Time corresponding to				0.33559
	1	39	50	Its log. in col. of rising is				3.94459
				Log. ratio				3.97028
								0.22303
				5588	Nat. number of	log.		3.74725
				24615				

Nat. co-sine ☉'s mer. zen. dist. $30203 = 72^{\circ} 25' N$.
Declination $23 \ 28 S$.

Latitude $48 \ 57 N$.

But as the latitude by computation differs considerably from that by account, the work must be repeated.

	H.	M.	S.	Lat. last found		Sec.
$\frac{1}{2}$ Elapsed time	1	50	0	$48^{\circ} 57'$		0.18262
Middle time	0	10	0	Declination	$23 \ 28$	0.08749
Time from noon	1	40	0	Log. ratio		0.22011
				Diff. N. sine 2432	Its log.	3.38596
					Its log.	0.33559
				Its log.		3.94166
				Its log. in col. of rising		3.97170
				Log. ratio		0.22011
				5644	Nat. number of	log.
				24615		3.7515
				30259	Nat. cos. mer. zen. distance	$72^{\circ} 23' N$.
					Declination	$23 \ 28 S$.
					True latitude	$48 \ 55 N$.

This latitude, differing only two miles from that used in the computation may be depended upon as the true latitude of the ship at the time of the second observation. If the first altitude had not been corrected, the computed latitude would have been found $= 48^{\circ} 40' N$.

* When the middle time is greater than half the elapsed time, both observations are on the same side of the meridian; otherwise, on different sides; whence it is easy to determine whether the greater latitude be observed before or after noon.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 141

EXAMPLE X.—(Same as Example VII. before given.)

The latitude by account $6^{\circ} 30'$ N. sun's declination $5^{\circ} 30'$ N. the sun's correct central altitudes $35^{\circ} 21'$ and $70^{\circ} 01'$, elapsed time 2h. 20' are given to find the true latitude.

Making the calculations with the latitude by account $6^{\circ} 30'$, the computed latitude by the first operation will be $8^{\circ} 17'$. Repeating the operation with the latitude $8^{\circ} 17'$, the second operation will give $7^{\circ} 10'$.^{*} This must be used for a third operation, and by repeating the calculation accurately to seconds, it will require more than a dozen operations to obtain the true latitude $7^{\circ} 38'$, which was found by the first method by a single operation. Dr. Brinkley made the latitude $7^{\circ} 30'$ differing 8' from a strict calculation by spherical trigonometry. The detail of this calculation is not here given, but is left to exercise the learner. The object of the present example is to shew how the number of operations might be decreased by the arithmetical method of *double position* before mentioned.

Take the error or difference between the first assumed latitude $6^{\circ} 30'$ and the first computed latitude $8^{\circ} 16'$ equal to 106'; also the error or difference between the second assumed latitude $8^{\circ} 16'$ and second computed latitude $7^{\circ} 10'$ which is 66'. Multiply them *crosswise* as in the adjoined scheme, according to the usual rule of *double position*,[†] dividing the sum of the products $1305^{\circ} 16'$ by the sum of the errors 172, gives the corrected latitude $7^{\circ} 35'$ N. The sum of the products was taken in this case, because one of the assumed latitudes was greater and the other less than its corresponding computed latitude. If both computed latitudes had been greater or both less than the corresponding assumed latitudes, the differences of the errors and of the products ought to have been taken. It will rarely happen that more than one process of this kind will be required to give a correct result. In the present instance, however, it will be necessary; for, by repeating the operation with the assumed latitude $7^{\circ} 35'$, the resulting computed latitude is $7^{\circ} 41\frac{1}{2}'$, and the third error $6\frac{1}{2}'$. Repeating anew the computation, with this and the second latitude $8^{\circ} 16'$ and second error 66', the resulting latitude is $7^{\circ} 38'$, the same as was found by the direct computation by the first method, and as accurately as could be obtained by repeating the operations about fourteen times by the second method.

In general, when such a large number of operations are required to produce a correct result, it is a sure proof that the situation of the object is not well adapted to obtain an accurate latitude, and it would be lost labour, and lead to great mistakes to attempt it. Thus, in the present example, if the greatest altitude had been decreased only $12' 42''$, making it $69^{\circ} 48' 12''$, leaving unaltered the other altitude $35^{\circ} 21'$ and the interval 2h. 20m. the latitude of the place of observation would be 0, or under the equator, as is easily proved by computing the altitudes of the sun for the times 1h. 17m. 50s.8 and 3h. 37m. 50s.8, under the equator when the declination is $5^{\circ} 30'$ N. by the rules hereafter given. Hence it appears that a change of $12' 42''$ in the greatest altitude, would alter the computed latitude from $7^{\circ} 38'$ to 0° , which makes an error of one degree of latitude for an error of $1\frac{1}{2}$ miles in that altitude, and as errors in the altitudes of this magnitude are easily committed at sea, even by very good observers, it shows very clearly the defect of the method of double altitudes when the sun approaches near to the zenith. This does not arise from any defect of the method of computation, but is an inherent defect of the method itself, which no process of spherics can remedy, and there is no other resource left, in such cases, than to make use of another object to determine the latitude.

Lats.	Errors.	Products.
$6^{\circ} 30' \times$	106	$= 876^{\circ} 16'$
$8^{\circ} 16' \times$	66	$= 429^{\circ} 00'$
	172	$)1305^{\circ} 16'$

^{*} Slight differences will be found in these calculations by using logarithms to seven places of figures and making the calculation accurately to seconds.

[†] If the degrees of both latitudes are alike, the minutes only may be retained in these multiplications.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 143

than 6 hours. This angle is to be marked *north* or *south*, with a different name from the declination d , at the greatest altitude. The co-secant of A is to be placed in Col. 2. its co-sine in Col. 3.

4. Place the declination D , corresponding to the *least* altitude, below the angle A , and if they are of the *same* name take their *sum*, but if of *different* names, take their *difference*, and call this sum or difference, the angle B , making it *north* or *south* like the greatest of the two quantities A , D . The co-sine of B is to be placed in Col. 2. its co-secant in Col. 3.

5. The sum of the three logarithms in Col. 3. (rejecting 20 in the index) is the co-tangent of an angle F , (less than 90°) which is to be taken out and marked *north* or *south*, with a different name from B .

6. The sum of the three logarithms in Col. 2 (rejecting 20 in the index) is the co-sine of the angle C , which is to be taken *less* than 90° , if B is less than 90° , but *greater* than 90° if B is greater than 90° . The angle C and its co-secant are to be placed in Col. 1.

7. Place the altitudes below C , take the *half sum* of these three quantities, subtract the greatest altitude from the half sum, and note the *remainder*. Place the secant of the *least* altitude in Col. 1. its co-tangent in Col. 2. its sine in Col. 3. The co sine of the *half sum* in Col. 1. and the sine of the *remainder* in Col. 1. The sum of the four last logarithms of Col. 1 (rejecting 20 in the index) being divided by 2, gives the sine of an acute angle, which being found and doubled, gives the zenith angle Z , which is to be named *north*, if the zenith and north pole are on the *same* side of the arch or great circle, passing through the two objects, (or the two observed places of the same object) but *south* if the zenith and *south* pole, are on the *same* side of that great circle.†

8. Take the *sum* of the angles Z and F , if they are of the *same* name, but their *difference* if of *different* names; this sum or difference is the angle G , to be marked *north* or *south* like the greatest of the angles Z , F .‡ The sine of G is to be placed in Col. 2.

9. The sum of the two lower logarithms of Col. 2. (rejecting 10 in the index) is the tangent of an angle I , which is to be taken out (less than 90°) and marked *north* or *south* like G . The secant of I is to be placed in Col. 3.

10. Write the declination D , corresponding to the *least* altitude below I , take their *sum* if of the *same* name, their *difference* if of *different* names. This sum or difference is the angle K , of the *same* name as the greater of these two quantities. The sine of K is to be placed in Col. 3.

11. The sum of the three last logarithms in Col. 3. is the sine of the required latitude of the *same* name as K .

EXAMPLE XI.

Given the sun's correct central altitude $41^\circ 39'$, and his declination $14^\circ N$. After an interval of 1h. 30m. by watch, his correct central altitude was 50° , and his declination $13^\circ 58' N$. Required the latitude, the sun being south of the observer when on the meridian?

† This rule is easily remembered in three places in which it occurs, from the circumstance that e is the letter of *sum* and *same*, and d the first letter of *difference* and *different*.

‡ If the sum be taken to find B and it exceeds 180° , subtract it from 360° , and call the remainder B with a different name from A , D .

This rule occurs also in the first and second methods of solution, and it must be determined on the spot by the situation of the objects. In double altitudes of the sun, moon, or planets, when the elapsed time is not very great, the angle Z is generally to be marked with the bearing of the zenith from the observed object, when at its greatest altitude on the meridian, which is north latitudes, without the tropics, is in general north, in south latitudes without the tropics, south. Sometimes when the sun is on the meridian near the zenith, it may be doubtful whether the zenith be north or south, in which case the problem may be solved for both cases, which increases the labor but little) and that one of the computed latitudes selected which agrees best with the ship's reckoning, but it is generally safest to use observations of this kind, which are generally liable to great errors from small mistakes in the observations.

§ If the sum be taken to find G , and it exceeds 180° , subtract it from 360° and call the remainder G , with a different name from Z or F .

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 145

EXAMPLE XIII.

Suppose, at the same moment of time, the moon's correct central altitude was $55^{\circ} 20'$, the moon's declination $0^{\circ} 36' N.$ the sun's correct central altitude $37^{\circ} 40'$, the sun's declination $0^{\circ} 17' S.$ The hour angle, or difference of the right ascensions of the sun and moon, being by the Nautical Almanac 5 hours or 75° . Required the latitude, supposing it to be north?

Col. 1.	Col. 2.	Col. 3.
Hour angle H 5h. (P. M. 10h.) sec. 10.58709	.....	..... tan. 10.57185
Decl. d (at gr. alt.) $0^{\circ} 36' N.$ tan. 8.02001	..... sine 8.02002	.....
A (diff. name from d.) 2 19 S. tan. 8.60704	A (same aff. as H.) co-sec. 11.33333	..... co-sine 9.93334
D Decl. (at least alt.) $0^{\circ} 17' S.$	.....	.....
B $2^{\circ} 36' S.$	..... co-sine 9.99355	..... co-sec. 11.34330
C $75^{\circ} 00'$ co-sec. 10.01506	C (same aff. as B) co-sine 9.41235	F $0^{\circ} 42' N.$ co-tan. 11.91489
Least altitude $37^{\circ} 40'$ sec. 10.10151	G sine 9.70375	Z $29^{\circ} 40' N.$ (F less 90° , diff. name fm. B.)
Greatest altitude .. $55^{\circ} 20'$	..... co-tan. 10.11241	G $30^{\circ} 22' N.$
Sun $168^{\circ} 00'$	I $33^{\circ} 13' N.$ tan. 9.81616	[I less 90°] sec. 10.07748
Sum $84^{\circ} 00'$ co-sine 9.01923	Dec. D $0^{\circ} 17' S.$ (at least alt.)	[I named as G.]
Sun $84^{\circ} 00'$ co-sine 9.01923	K $32^{\circ} 56' N.$ sine 9.73433	.....
S-gr. alt. = Rem. $28^{\circ} 40'$ sine 9.68038	Latitude $23^{\circ} 24' N.$ sine 9.59330	.....
Sum of 4 logs. 2) 18.81678	.....	.....
Z $14^{\circ} 50'$ sine 9.40639	.....	.....
Z $29^{\circ} 40' N.$ (named like bearing of Zenith.)	.....	.....

If the zenith had been south of the great circle passing through the objects, we should have Z $29^{\circ} 40' S.$ G $28^{\circ} 58' S.$ I $32^{\circ} 6' S.$ K $32^{\circ} 23' S.$ and the latitude $22^{\circ} 44' S.$

EXAMPLE XIV.

Given the moon's correct central altitude $47^{\circ} 57'$, the moon's declination $17^{\circ} 29' S.$ the sun's correct central altitude, at the same time, $27^{\circ} 22'$, the sun's declination $8^{\circ} 28' S.$ the hour angle, or difference of right ascensions of the sun and moon, 5h. 10m. 28s. or $85^{\circ} 7'$. Required the latitude, supposed north?

Col. 1.	Col. 2.	Col. 3.
Hour angle H 5h. 10m. 28s. (P. M. 11h. 20' 56'') sec. 11.06835	.....	..... tan. 11.06835
Decl. d (at gr. alt.) $17^{\circ} 29' S.$ tan. 3.49828	..... sine 9.47774	.....
A (diff. name from d.) $74^{\circ} 53' N.$ tan. 10.56821	A (same aff. as H.) co-sec. 10.01529	..... co-sine 9.41628
D Decl. (at least alt.) $8^{\circ} 28' S.$	.....	.....
B $66^{\circ} 25' N.$	..... co-sine 9.00215	..... co-sec. 10.03728
C $82^{\circ} 51'$ co-sec. 10.00336	C (same aff. as B) co-sine 9.03518	F $16^{\circ} 43' S.$ co-tan. 10.52251
Least altitude $27^{\circ} 22'$ sec. 10.03155	G sine 9.58497	Z $39^{\circ} 20' N.$ (F less 90° , diff. name fm. B.)
Greatest altitude .. $47^{\circ} 57'$	..... co-tan. 10.28596	G $22^{\circ} 57' N.$
Sun $157^{\circ} 50'$	I $30^{\circ} 37' N.$ tan. 9.87036	[I less 90°] sec. 10.09518
Sum $78^{\circ} 55'$ co-sine 3.28384	Dec. D $8^{\circ} 28' S.$ (at least alt.)	[I named as G.]
Sun $78^{\circ} 55'$ co-sine 3.28384	K $28^{\circ} 03' N.$ sine 9.67571	.....
S-gr. alt. = Rem. $31^{\circ} 18'$ sine 9.71560	Latitude $15^{\circ} 41' N.$ sine 9.43168	.....
Sum of 4 logs. 2) 19.05433	.....	.....
Z $19^{\circ} 40'$ sine 9.52719	.....	.....
Z $39^{\circ} 20' N.$ (named like bearing of Zenith.)	.....	.....

If the zenith had been south of the great circle passing through the objects, we should have Z $39^{\circ} 20' S.$ G $56^{\circ} 3' S.$ I $58^{\circ} 2' S.$ K $66^{\circ} 30' S.$ and the latitude $52^{\circ} 16' S.$

TO FIND THE LATITUDE BY DOUBLE ALTITUDES. 147

3. The sum of the two logarithms in Col. 2. is the tangent of the angle I. which is to be taken less than 90° , and marked *south* if the angle G is less than 90° , but *north* if G is more than 90° . Place the secant of I in Col. 3.

5. Place the declination corresponding to the least altitude, below I; Take the sum if of the same name, but their difference if of different names; call this sum or difference the angle K, and mark it with the same name as the greatest of the two quantities. Place the sine of K in Column 3.

6. The sum of the three logarithms in Col. 3. (rejecting 20 in the index) is the sine of the latitude of the same name as K.

Having found the latitude, the hour may be obtained by means of the true altitude and declination of the sun or star, by any of the usual methods hereafter given for that purpose; but, if the last of the observed altitudes was that of the sun or star, the horary distance of that object from the meridian might be obtained more simply by the following rule, adapted to Table XXVII.

RULE.—Add the tangent of the angle G, the sine of the angle I, the secant of the angle K, the sum, rejecting 20 in the index, is the tangent of an angle; take out the corresponding time in the Column P. M. or in the Column A. M. increased by 12 hours, half of either of these times is the horary distance of the lowest observed object from the upper or lower meridian, whence the hour may be obtained directly if it be the sun, but if it be the star (or moon) it is obtained by applying its horary distance to the hour of passing the meridian, according to the usual methods of finding the time from an altitude of a fixed star, or the moon.

EXAMPLE.—(Same as Dr. Brinkley's N. A. 1825.)

May 19d. 8h. 6m. P. M. in the longitude of 7h. 23m. west, it was found by working a lunar observation that the correct distance of the centres of the sun and moon was $90^\circ 57' 20''$; true altitude of the sun's centre $11^\circ 33' 12''$; true altitude of the moon's centre $27^\circ 52' 18''$. At the same time by the Nautical Almanac the sun's declination was $19^\circ 56' 48''$ N. the moon's declination $15^\circ 55' 48''$ N. Required the latitude and hour by this observation?

Col. 1.	Col. 2.	Col. 3.
True distance $90^\circ 57' 20''$ co-sec. 10.00000		
P. dist. at least 70 03 12 co-sec. 10.00087		
P. dist. at great 76 04 12		
Sum 237 04 44	G is sum of F, Z, if north pole and zenith are on same side of of great circle, but their difference if of different sides.	
Sum 118 32 22 sine 9.34374		
S. decl. at great 42 28 10 sine 9.82943		
		2)19.60010
F 52 36 00 sine 9.90005	Z 01 36 52	I is less than 90° ,—named south if G is less than 90° , north if G is more than 90° .
Angle F 105 12 00	F 105 12 00	
True distance 90 57 20 co-sec. 10.00000	G 166 48 52 co-sine 9.36840	
Least alt. 11 33 12 sec. 10.00886	co-tan. 10.69947	sine 9.50163
Greatest alt. 27 52 18	I 78 03 33 N. tan. 10.67767	sec. 10.08723
Sum 130 02 50	Dec. 19 56 48 N. (at least alt.)	
Sum 65 01 25 co-sine 9.62357	K 92 05 21 N. sine 9.98506	
Sum—gr. alt. 37 29 07 sine 9.78430		Latitude $71^\circ 48'$ N. sine 9.92452
		2)19.41881
Angle Z 30 48 25 sine 9.70940		
Angle Z 01 36 52		

To find the Hour.
 G tan. 9.36840
 I sine 9.98506
 K sec. 10.85166

Hour P. M. 7h. 47m. 42s. or A. M. +12h. = 16h. 12m. 12s. tan. 10.21203

Divided by 2 gives the horary distance of } 3h. 53m. 51s. or 8h. 06m. 03s.
 the lowest object from the meridian, }

The sun being at the lowest altitude, his distance from the upper meridian was 8h. 6m. 9s. being the hour of the day, and the sun's distance from the lower meridian, or midnight, was 3h. 53m. 51s.

* Both these logarithms may be taken out at the same time when the sine of the angle was found in the computation of the angle Z.

TO FIND THE LATITUDE BY ONE ALTITUDE. 149

RULE.

Add together the log. co-sine of the latitude by account (Table XXVII.) the log. co-sine of the declination (Table XXVII.) the logarithm in the column of rising (Table XXIII.) corresponding to the time from noon when the observation was taken; reject 20 in the index, the natural number of the remainder being found (in Table XXVI.) and added to the natural sine of the observed altitude (Table XXIV.) the sum will be the natural co-sine of the meridian zenith distance, from which the latitude may be obtained by the common rules.

If the computed latitude differs considerably from the latitude by account, it is best to repeat the operation, using the latitude last found instead of the latitude by account. This method of finding the latitude by a single altitude of the sun, may be applied to any other celestial object.

EXAMPLE I.

Being at sea in latitude $49^{\circ} 50'$ N. by account, when the sun's declination was 20° S. at 11h. 29m. 20s. A. M. per watch, regulated the preceding morning, in a place 20 miles of longitude to the eastward, the sun's correct central altitude was $19^{\circ} 41'$ bearing south. Required the true latitude?

	H.	M.	S.			
Time per watch.....	11	29	20	Latitude	$49^{\circ} 50'$	Co-sine 9.80957
20 in T. by Tab. XXI.	1	20		Declin.	$20^{\circ} 0'$	Co-sine 9.97299
Time of observation..	11	28	0	Time from noon	0h. 32m. 0s.	Log. rising 2.93820
		12				
Time from noon.....	32	0		Central altitude	$19^{\circ} 41'$	Nat. Num. 590 log. 2.77076
						Sine 33582
				Mer. zen. dist.	$69^{\circ} 57' N.$	Co-sine 34272
				Declination	$20^{\circ} 0' S.$	---
				Latitude	$49^{\circ} 57' N.$	

EXAMPLE II.

At sea in the latitude of 60° N. by account, the sun being on the equator, at 0h. 59m. 0s. P. M. per watch, regulated the preceding morning in a place 15 miles in longitude to the westward, the sun's correct central altitude was $28^{\circ} 55'$ bearing south. Required the latitude?

	H.	M.	S.			
Time per watch	0	59	0	Latitude	$60^{\circ} N.$	Co-sine 9.69897
15 long. in time	1	0		Declination	0°	Co-sine 10.00000
Time from noon	1	0	0	Time from noon	1h. 0m.	Log. rising 3.53243
				Central altitude.....	$28^{\circ} 55'$	Nat. Numb. 1704 log. 3.23140
						Sine .....48303
				Mer. zenith distance..	$60^{\circ} 0' N.$	Co-sine ....50007
				Declination.....	$0^{\circ} 0'$	---
				Latitude	$60^{\circ} 0' N.$	

When the observation is taken a few minutes before or afternoon, the correction to be applied to the altitude, to obtain the meridian altitude, may be found by means of Tables XXXII. XXXIII. the first of which contains the variation of the altitude for one minute from noon, expressed in seconds and tenths—the other contains the square of the minutes and seconds of a minute contained in the top and the side columns. By these tables the correction of the observed altitude may be found by the following rule.

The observed altitude of the lower limb being $15^{\circ} 32'$, ☉'s semi-diameter 16'. Dip 4'. Refraction 5'. Parallax too small to be noticed.

The observed altitude of the sun's lower limb being $23^{\circ} 43'$, ☉'s S. D. 16'. Dip 4'. Refraction 5'. Parallax too small to be noticed.

TO FIND THE LATITUDE BY ONE ALTITUDE. 151

EXAMPLE V.

Having regulated my watch, I found it to be 6' 2" too slow for apparent time. I then sailed to the southward and eastward till the ship had made 60' difference of longitude, and was by account in the latitude of 40° N. the sun's declination being 20° S. The sun being then nearly on the meridian I observed ten altitudes of his lower limb by a circle of reflection and noted the times by the watch as in the following table, and the sum of all the altitudes taken from the circle was 298° 20'.—Required the true latitude, supposing the dip to be 4' and the semi-diameter 16'?

When it was 12 o'clock by the watch it was 12h. 6m. 2s. apparent time at the place where the watch was regulated, and 12h. 10m. 2s. apparent time at the place where the altitudes were taken to determine the latitude, because the former place was 60' or 4' in time to the westward of the latter, consequently the watch was 10m. 2s. too slow for app. time at the place of taking the altitudes for determining the latitude. Hence we may determine the time from noon of taking each observation, as in the second column of the adjoined Table, and find the numbers corresponding in Table XXXIII. the mean of which is 6.97, this multiplied by the number in Table XXXII. corresponding to the latitude 40° N. and declination 20° S. viz. 1'.6 will give 11".152 or 11", which is the correction to be added to the mean of the observed altitudes to obtain the meridian altitude.

Time per watch	Time from noon.	Numbers Tab. XXXIII.
11.45.13	4' 15"	18.1
46.58	3 0	9.0
47.52	2 6	4.4
48.50	1 8	1.3
49.28	0 30	0.2
50.48	0 50	0.7
51.10	1 12	1.4
52.13	2 15	5.1
53. 8	3 10	10.0
54.23	4 25	19.5
Sum		69.7
		Mean 6.97

Now the sum of all the altitudes 298° 20', divided by 10, the number of observations gives	29	50'	0
Add semi-diameter 16' and the above correction 11"	+	16	11
Add parallax found in Table XIV.	+		8
Subtract dip 4' and refraction 1' 59"	—	5	39
Central Altitude.	30	0	40
Zenith distance	59	59	20 N.
Declination	20	0	0 S.
Latitude	39	59	20 N.

When the meridian altitude of the object is small, the correction of altitude may be found by this method, for 12 or 15 minutes from noon, to a great degree of accuracy; when the sun passes near the zenith, the time of observation must be proportionally nearer to noon. Thus in Example I. preceding, the time from noon was 32', and as the numbers in Table XXXIII. are the squares of the number of minutes, it follows, that the number corresponding to 32' would be the square of 32 or 1024.0. This multiplied by the number 1'.3 of Table XXXII. corresponding to the latitude 50° N. and declination 20° S. will give the correction 1331'.2 or nearly 22', which added to 19° 41' will give 20° 3' for the meridian altitude, or 69° 57' for the zenith distance, being the same as in that example.

It is very advantageous in this method to observe as many altitudes in the afternoon as before noon, and at nearly the same distances from noon, for in this case a small error in the regulating of the watch will not materially affect the calculation. This will appear evident by supposing, in the preceding example, that the watch was 11' 2" too slow. instead of 10' 2", by which means the times and numbers will be as in the adjoined Table, and the mean of all the numbers taken from Table XXXIII. will be 8.15, which multiplied by 1'.6 will give 13" nearly, for the correction instead of 11", so that in this case an error of one minute in the regulation of the watch would only cause an error of 2 seconds in the meridian altitude.

But it must be carefully observed that in using this method you must not take the observation more than 2 or 3 minutes from noon when the sun passes within 10° or 12° of the zenith.

Times.	In Tab. XXXIII.
3.15	10.6
2. 0	4.0
1. 6	1.2
0. 8	0.0
0.30	0.2
1.50	3.4
2.12	4.8
3.15	10.6
4.10	17.4
5.25	29.3
Sum	81.5
	Mean 8.15

TO DETERMINE THE LATITUDE ON SHORE, &c. 153

Altitudes may be observed in this manner in taking an azimuth for determining the variation, or for regulating a watch in the manner explained in this work.—Observing in all cases, that the half of the observed angle is to be corrected for refraction, parallax, and semi-diameter, but not for the dip of the horizon; and that half the index error only is to be applied.

TO FIND THE LATITUDE BY AN ALTITUDE OF THE POLAR STAR.

In northern climates the latitude may be determined by means of an observed altitude of the Polar Star, provided the apparent time of observation can be ascertained within a few minutes.* This method might be frequently used at sea, when the horizon is well defined, if that star were of the 1st magnitude, but being only of the 2d. or 3d. magnitude, it is sometimes so dim that it is rather difficult to determine the altitude with precision. However, as there are times when it would be of great importance to determine the latitude within 10 or 12 miles, it was thought advisable to explain this method, which may be used when observations of the sun or moon cannot be obtained.

Having therefore the apparent time of observation (which must be reckoned from noon to noon in numerical succession, that is 6h. A. M. must be called 18h. &c.) and the observed altitude of the star determined by a fore-observation, you must subtract from the altitude the dip, which is in general 4 minutes, and the refraction, and you will obtain the true altitude of the star. Then the sun's right ascension corresponding to the given day, must be found in Table VI.† and added to the apparent time of observation (rejecting 24 hours when the sum exceeds 24 hours) with that sum enter the adjoining table and take out the corresponding correction, which must be added to, or subtracted from the true altitude, according to the directions in the table—the sum or difference will be the latitude of the place of observation.

Find in the side column the sum of the hour of the day and the sun's right ascension, and the number in the middle column will be the correction of the true altitude.				
If the hour is found in these columns, the correction is subtractive		Correction of the altitude.	If the hour is found in these columns, the correction is additive.	
h. m.	h. m.	°	h. m.	h. m.
0. 58	0. 58	1. 38	12. 58	12. 58
1. 3	0. 53	1. 38	12. 53	13. 3
1. 13	0. 43	1. 38	12. 43	13. 13
1. 23	0. 33	1. 38	12. 33	13. 23
1. 33	0. 23	1. 37	12. 23	13. 33
1. 43	0. 13	1. 36	12. 13	13. 43
1. 53	0. 3	1. 35	12. 3	13. 53
2. 3	23. 53	1. 34	11. 53	14. 3
2. 13	23. 43	1. 33	11. 43	14. 13
2. 23	23. 33	1. 31	11. 33	14. 23
2. 33	23. 23	1. 30	11. 23	14. 33
2. 43	23. 13	1. 28	11. 13	14. 43
2. 53	23. 3	1. 26	11. 3	14. 53
3. 3	22. 53	1. 24	10. 53	15. 3
3. 13	22. 43	1. 22	10. 43	15. 13
3. 23	22. 33	1. 19	10. 33	15. 23
3. 33	22. 23	1. 16	10. 23	15. 33
3. 43	22. 13	1. 14	10. 13	15. 43
3. 53	22. 3	1. 11	10. 3	15. 53
4. 3	21. 53	1. 8	9. 53	16. 3
4. 13	21. 43	1. 5	9. 43	16. 13
4. 23	21. 33	1. 1	9. 33	16. 23
4. 33	21. 23	0. 58	9. 23	16. 33
4. 43	21. 13	0. 54	9. 13	16. 43
4. 53	21. 3	0. 51	9. 3	16. 53
5. 3	20. 53	0. 47	8. 53	17. 3
5. 13	20. 43	0. 43	8. 43	17. 13
5. 23	20. 33	0. 39	8. 33	17. 23
5. 33	20. 23	0. 36	8. 23	17. 33
5. 43	20. 13	0. 32	8. 13	17. 43
5. 53	20. 3	0. 27	8. 3	17. 53
6. 3	19. 53	0. 23	7. 53	18. 3
6. 13	19. 43	0. 19	7. 43	18. 13
6. 23	19. 33	0. 15	7. 33	18. 23
6. 33	19. 23	0. 11	7. 23	18. 33
6. 43	19. 13	0. 6	7. 13	18. 43
6. 53	19. 3	0. 2	7. 3	18. 53
6. 58	18. 58	0. 0	6. 58	18. 58

* If the star is not far from the meridian, an error of half an hour in the time would not affect the latitude above 1 or 2 miles.

† It is accurate enough to take the numbers given in the table; but in strictness the right ascension ought to be taken from the Nautical Almanac, for the hour of observation, reduced to Greenwich time, by adding or subtracting the longitude turned into time.

In some of the copies of the second edition of this work, the words additive and subtractive were printed in the wrong columns. This table will require a correction after a few years, on account of the variation of declination, and right ascension of the star. It corresponds nearly to the year 1824, for every year after that time you must add one quarter of a minute to the times in the side columns, and decrease the tabular corrections of altitude about $\frac{1}{100}$ part. Thus for the year 1836 the times must be increased 3m. for the 12 years, so that 0h. 58' must be called 1h. 1m. and all the corrections of altitude must be decreased $\frac{1}{100}$ part, so that 1° 16' must be 1° 15' nearly and 0° 33' must be 0° 32' nearly.

TO FIND THE TIME AT SEA, AND REGULATE A WATCH. 155

which may be found. A small correction is necessary for the variation of the sun's declination during the interval between the observations, and the method of calculating this correction will be given in this work, but this method cannot often be made use of at sea by reason of the motion of the vessel.

The best method of obtaining the apparent time at sea, is by observing, by a fore observation, the altitude of the sun's lower limb when rising or setting fastest, or when bearing nearly E. or W. to this altitude we must add the semi-diameter and parallax, and subtract the dip (or instead of these three corrections add $12'$,* which will answer very well for an observation taken on the deck of a common sized vessel;) subtract also the refraction taken from Table XII. and the remainder will be the correct altitude. The ship's latitude must be found at the time of observation by carrying the reckoning forward to that time. The declination must be taken from Table I. or from the Nautical Almanac, and corrected for the ship's longitude, and the distance of the sun from the meridian by Table V. Then if the latitude and declination be both north or both south, subtract the declination from 90° and you will have the polar distance; but if one be north and the other south, add the declination to 90° and you will have the polar distance.

Having thus found the correct altitude, latitude, and polar distance, the apparent time of observation may be found by either of the three following methods, of which the first is the most simple, since it does not require a table of natural sines, all the logarithms being found in Table XXVII. This method is abridged by means of the table of hours affixed to the table of log. sines; in using which you must observe, that if the sine or co-sine of the logarithm sought is marked at the top of the table, the name of hour whether A. M. or P. M. is also to be found at the top, and the contrary if the sine or co-sine is marked at the bottom.

To find the apparent time by the sun's altitude.

FIRST METHOD.

Add together the correct altitude of the sun's centre, the latitude and the polar distance; from the half sum subtract the sun's altitude, and note the remainder. Then add together the log. secant of the latitude (this and all the other logs. being found in Table XXVII.) the log. co-secant of the polar dist. (re-
ferring 10 in each index) the log. co-sine of the half sum, and the log. sine of the remainder, half the sum of these four logarithms being sought for in the column of log. sines, will correspond to the hour of the day in one of the hour columns.

EXAMPLE I.

Suppose that on the 10th of October, 1824, sea account, at 8h. 21m. A. M. per watch, in the latitude of $51^\circ 30'$ N. and long. 114° E. from Greenwich by account, the altitude of the sun's lower limb by a fore-observation is $15^\circ 32'$, the correction for semi-diameter, parallax and dip $12'$ —Required the apparent time of observation?

By example III. page 111, the declination was $6^\circ 34'$ S. this added to 90° gives the polar distance $96^\circ 34'$. To the sun's observed altitude $15^\circ 32'$, I add $12'$ miles and subtract the refraction $4'$, the remainder is the correct altitude $15^\circ 40'$.

* The semi-diameter is in general about $16'$, the parallax never exceeds $3''$, and the dip is about $4'$; as the two former corrections are additive and the latter subtractive, the effect of all three corrections will not differ materially from $12'$ additive.

TO FIND THE TIME AT SEA, AND REGULATE A WATCH. 157

complement of latitude; then add together the zenith distance, co-latitude, and polar distance, from half their sum subtract the zenith distance, and note the remainder; then add together the log. co-secant of the co-lat. (this and all the other logs. being found in Table XXVII.) the log. co-secant of the polar distance (rejecting 10 in each index) the sine of the half sum and the sine of the remainder, half the sum of these four logarithms being found among the log. co-sines, will correspond in one of the adjoined columns to the time of day.

The two preceding examples are thus worked by this method.

EXAMPLE I.

	90° 0'			90° 0'		90° 0'	
☉'s cor. alt.	13 40			latitude	51 30	☉'s dec.	6 34
Zen. dist.	76 20			co-lat.	38 30	Pol. dist.	96 34
Co-lat.	38 30	co-secant	0.20585				
Pol. dist.	96 34	co-secant	0.00286				
Sum	211 24						
1/2 Sum	105 42	sine	9.98349				
Zen. dist. ...	76 20						
Rem.	29 22	sine	9.69055				
			2)19.89275				

co-sine 9.94137 corresponding to which in the column
 1. M_1 is 8h. 7m. 9s. the time of day, which agrees with the other method.

EXAMPLE II.

☉'s cor. alt.	90° 0'		latitude	90° 0'	☉'s dec.	90° 0'
	15 54			39 54		17 28
Zen. dist.	74 6		co-lat.	50 6	Pol. dist.	72 32
Co-lat.	50 6	co-sec.	0.11511			
Pol. dist.	72 32	co-sec.	0.02050			
Sum	196 44					
1/2 Sum	98 22	sine	9.99535			
Zen. dist.	74 6					
Remainder	24 16	sine	9.61382			
			2)19.74478			

P. M. is 5h. 34m. 27s. the time of day; which agrees nearly with the first method.

By the preceding method you may find the beginning or ending of the twilight, by calculating the hour when the sun's zenith distance is 108° (or when the sun is 18° below the horizon) for by observation it has been found that the twilight begins or ends when the sun is at that distance from the zenith.

EXAMPLE.

Required the time of beginning and ending of the twilight, June 23, 1820, at Boston?

Zen. dist.	108° 0'		
Co-lat.	47 37	co-secant	0.13156
Pol. dist.	66 33	co-secant	0.03744
Sum	<u>222 10</u>		
$\frac{1}{2}$ Sum	<u>111 5</u>	sine	9.96991
Zen. dist.	<u>108 0</u>		
Remainder	3 5	sine	8.73069
		sum	<u>18.86960</u>

$\frac{1}{2}$ sum co-sine 9.43480 which corresponds to 2h. 6m. 20s. A. M. and 9h. 53m. 40s. P. M. Therefore, the first appearance of the twilight in the morning was at 2h. 6m. 20s. and the end of it in the evening at 9h. 53m. 40s.

· TO FIND THE TIME AT SEA, AND REGULATE A WATCH. 159

page 2d. of the month in the Nautical Almanac, the remainder will be the approximate time at the ship. To this time apply the longitude of the ship from Greenwich, turned into time, by adding in west longitude or subtracting in east longitude, the sum or difference will be the apparent time of the observation nearly, at the meridian of Greenwich.* Take from the Nautical Almanac the sun's right ascension for the preceding and following noons, and take the difference, which seek for at the top of Table XXXI.† and the hours and minutes of the time at Greenwich in the side column, the corresponding correction being subtracted from the approximate time at the ship, will give the apparent time required.

EXAMPLE I.

Suppose that on September 9, 1820, sea account, in latitude $7^{\circ} 45' \text{ S.}$ and longitude $30^{\circ} 18' \text{ E.}$ from Greenwich, the altitude of the star Procyon, being *then* east of the meridian, was $28^{\circ} 16'$ and the dip $4'$. Required the time of observation?

By Table VIII. for the year 1820.

Procyon's right ascension	7h. 29' 52"	Dec.	5° 41' N.
Variation in 8½ months	2	Var.	0
Star's right ascension	7 29 54	Dec.	5 41 N.
Star's obs. alt.	28° 16'		90
Dip	4	Pol. dist.	95 41
	28 12		
Ref. Table XII....	2		
Correct altitude....	28 10	secant ...	0.00399
Latitude	7 45	co-sec. ...	0.00214
Polar distance	95 41		
Sum	2)131 36		
½ Sum	65 48	co-sine ...	9.61270
Alt.	28 10		
Remainder.....	37 38	sine	9.78576

the column P. M. is	4h. 2m. 2s.
Star's right ascension	7 29 54

Sept. 9. sea account, is September 8, by N. A. sun's R. A. noon	11	7	20
---	----	---	----

Approximate time at the ship	16	20	32
Ship's longitude 30° 18' in time ..	2	1	12

Time at Greenwich nearly 14 19 20
11h. 7m. 20s.
11 10 56

Daily difference 3 36 The correction of Table XXXI.
 corresponding, is 3m. 9s. which being subtracted from the approximate time 16h. 20' 32"
 gives the apparent time at the ship 16h. 18' 23" or 4h. 18' 23" A. M.†

* When the sum exceeds 24 hours, you must subtract 24 hours and add 1 to the day of the month, and then the hours to be subtracted are more than the hours of the time at the ship, you must add 24 hours to the latter, previous to the subtraction, and take 1 day from the day of the month.

† Table XXXI. is only calculated to 12 hours. If the time at Greenwich exceeds 12 hours, you must take out the correction for 12 hours, and add it to the correction taken out for the rest of the time; the sum will be the sought correction.

‡ If the ship was furnished with a Chronometer regulated to Greenwich time, the \odot 's Right Ascension might have been found at once from the Nautical Almanac to be the sum of 11h. 7m. 20s. and 2m. 28s. equal to 11h. 9m. 28s. which subtracted from 27h. 27m. 52s. gives the apparent time at the ship 16h. 18m. 24s. more simply than by the above method. The same remark will apply to other examples.

160 TO FIND THE TIME AT SEA, AND REGULATE A WATCH.

EXAMPLE II.

Suppose that on April 16, 1820, sea account, in lat. $48^{\circ} 57'$ N. and long. 66° W. the observed altitude of Aldebaran when west of the meridian was $22^{\circ} 25'$, and the dip $4'$. Required the apparent time at the ship?

By Table VIII. for the year 1820, R. As. Aldeb.....		H. M. S.	Dec.	
Variation for $3\frac{1}{2}$ months		4 25 36	16° 8' N.	
		1	Var.	0
		<hr/>		
		Star's right asc.	4 25 37	Dec. 16 8 N.
				90
				<hr/>
				P. dist. 73 58
Obs. alt. Aldeb....	22° 25'			
Dip	4			
	<hr/>			
	22 21			
Refraction	2			
	<hr/>			
Cor. alt. Aldeb. ..	22 19			
Latitude	48 57	secant	0.18262	
Pol. dist.	73 52	co-sec.	0.01745	
	<hr/>			
Sum	2)145 8			
	<hr/>			
$\frac{1}{2}$ Sum	72 34	co-sine	9.47654	
Alt.	22 19			
	<hr/>			
Remainder	50 15	sine	9.89584	
		sum	2)19.56245	
			<hr/>	
		$\frac{1}{2}$ sum sine ..	9.78122	corresponding to $4^{\text{h}} 57^{\text{m}} 34^{\text{s}}$
in the column P. M. is		Star's right ascension.....	4 25 37	
			<hr/>	
		Right ascen. of the meridian....	9 23 1	
April 16, sea account, is April 15, by N. A. when \odot 's rt. asc. noon		1 34 12		
		<hr/>		
		Approximate time at ship.....	7 48 49	
		Long. 66° W. in time	4 24	
		<hr/>		
		App. time at Greenwich.....	12 12 49	
Sun's right ascen. April 15, 1h. 34m. 12s.				
April 16, 1 37 54				
Daily difference	3 42	the correction of Table XXXI. corresponding, is 1m. 53s. which being subtracted from the approximate time at the ship,		
		7h. 48' 49"		
		<hr/>		
leaves the apparent time at the ship	7 46 56 P. M.			

This method of obtaining the time by the stars would be accurate if a good horizon could be obtained; but as that is not always the case, it is best to regulate your watch by the sun:

To regulate a watch by equal altitudes of the sun.

A watch may be regulated on shore by observing in the morning and evening the times when the sun is at the same altitude,* for the middle between these times would be the apparent time of noon by the watch if the declination of the sun remained the same during the observation; but if the declination varies, as is generally the case, the apparent time of noon determined in this manner (which for distinction we shall call the middle time) must be corrected for the change of declination by an equation, called the equation of equal altitudes, and the middle time thus corrected will be the true time.

* The altitudes should be taken when the sun rises or falls fast. The best time for observation is when the bearing of the sun is east or west. In general two or three hours from noon will be sufficient. An artificial horizon, formed by a vessel filled with mercury, may be used in taking these altitudes.

FIND THE TIME AT SEA, AND REGULATE A WATCH. 161

Set time of apparent noon by the watch. For greater accuracy, several observations should be taken in the morning, and corresponding ones in the afternoon, and the mean of the times of the morning and evening observations should be respectively taken, and the equation of equal altitudes corresponding to the mean of all the observations calculated and applied to the middle time, as if a single set of observations only had been taken.

In noting the times of observation, you must count the hours in numerical succession, so that if some of the observations are taken before 12h. by the watch, and others after 12h. the next hour to 12h. must be called 13h. the 14th. &c. Half the sum of the times of observation, corresponding to any number of observations (or the mean of a number of observations) will be the middle time, and the difference of the times of observation will be the elapsed time. The equation of equal altitudes consists of two parts, which may be called by the following rule:

Rule 1.—To the constant log. 8.8239 add the log. co-tangent of the latitude, the log. corresponding to the elapsed time found in the column P. M. of Table XXVII. the log. of the hours and minutes of the elapsed time, reckoned as minutes and seconds, and the prop. log. of the daily variation of the sun's declination, the sum, rejecting 10 in the index, will be the prop. log. of the first part of the equation of equal altitudes, reckoning minutes and seconds as seconds and thirds respectively.

To the constant log. 8.8239 add the log. co-tangent of the sun's declination, the log. tangent corresponding to the elapsed time found in the column P. M. of Table XXVII. the prop. log. of the hours and minutes of the elapsed time reckoned as minutes and seconds, and the prop. log. of the daily variation of the sun's declination, the sum, rejecting 30 in the index, will be the prop. log. of the second part of the equation of equal altitudes, reckoning minutes and seconds as seconds and thirds respectively.

The first part of the equation of equal altitudes is to be added to the middle time when the sun is receding from the elevated pole, otherwise subtracted, * and the second part is added when the declination is increasing, but subtracted when decreasing; these corrections, being applied to the middle time, will give the apparent time of noon by the watch.

EXAMPLE.

Suppose that on the 9th. of May, 1820, civil account, in the latitude of 40° N. and 10° W. the following observations were taken at equal altitudes of the sun. Required the error of the watch?

Alt. \odot 's L. L.	Times per watch.		Times per watch.	
	A. M.		P. M.	
$15^{\circ} 33'$	6h. 29m. 51s.		17h. 32m. 18s.	
$15^{\circ} 45'$	6 31 7		17 31 0	
$15^{\circ} 55'$	6 32 14		17 29 52	
Sum	93	12	93	12
Mean	6 31	4	17 31	4
			6 31	4
Difference is elapsed time	11 0 0		11 0 0	
Sum	2) 22 0 0		2) 22 0 0	
Middle time	12 1 0		12 1 0	
Constant log.	8.8239		8.8239	
40° co-tang.	10.0762		dec. 17.25 cot.	10.5035
Time 11h. Sine	9.9963		tang.	10.8806
Time 11h. or 11' P. L.	1.2139			1.2139
Dec. $15^{\circ} 45' 7''$ P. L.	1.0566			1.0566
Sum	1.1669		2d. part $0^{\circ} 36''$ P. L.	2.4785

The first part of this equation $12^{\circ} 15''$ is subtractive, because the sun is proceeding towards the elevated pole; and the second part $36''$ is additive, because the declination is increasing, so that the whole equation is about 12 seconds subtractive; this applied to the middle time 12h. 1m. 4s. gives the time of apparent noon by the watch 12h. 52s. so that the watch is 52 seconds too fast for apparent time.

In north latitudes the first part is to be added from the summer to the winter solstice, and subtracted the rest of the year. To have supposed that the elapsed time is less than 12 hours, which is generally the case, but if it exceeds 12 hours, the second part must be applied in a contrary manner to the above rule. Thus if at noon, by the Nautical Almanac, the declination was $17^{\circ} 21' 42''$, and on the following day $17^{\circ} 30'$, the difference $15' 48''$, being the daily variation. The declination corresponding to the 10th. being $17^{\circ} 25' 10''$ N. nearly.

The angular distances of the moon from the sun and proper stars, are generally given in the Nautical Almanac from one object on each side of her, to afford a greater number of opportunities of observation, and to enable the observer to correct in a great degree, the errors of the instrument, the adjustments, or a faulty habit of observing the contact of the limbs, because these errors have a natural tendency to correct each other, in taking the mean of observations made with stars on different sides of the moon. Previous to taking the observation, the Nautical Almanac must be examined, to see from what objects the distances are computed, and from those objects only must the distances be measured.

There are only nine stars from which the angular distances are computed in the Nautical Almanac; and as it is of the greatest importance to be able to discover them easily, I shall here add a number of remarks which will be found useful for that purpose.

The best way of discovering any star, is by means of a celestial globe. If that cannot be obtained, the time of the star's passing the meridian, and its meridian altitude, may be calculated, and by observing at that time, the star may be easily discovered. The distances marked in the Nautical Almanac afford also to the observer an easy method of knowing the star from which the moon's distance is to be observed; for he has nothing to do but to set the sextant or circle to the distance computed roughly for the apparent time, estimated nearly for the meridian of Greenwich, and direct his sight to the east or west of the moon, according as the distance at Greenwich was found in the VIII. IX. X. and XI. pages of the month: and having found the reflected image of the moon upon the horizon glass, sweep the instrument to the right or left, and that image will pass over the sought star, if above the horizon, and the weather clear: the star is always one of the brightest, and is situated nearly in a line perpendicular to the moon's horns, or which is the same thing, in the line of the moon's shorter axis produced.

The computed distance made use of in sweeping for the star, may be found in this manner. Reckon the apparent time at the ship in the manner of astronomers (by counting 24 hours from noon to noon, and taking the day one less than the sea account;) to this time apply the longitude turned into time, by adding in west, and subtracting in east longitude; the sum or difference will be the apparent time at Greenwich nearly. Take the distances from the Nautical Almanac for the time immediately preceding and following this estimated time, and note the difference of these distances: Then say as 3h. or 180' is to the difference of the distances, so is the difference between the apparent time at Greenwich and the next preceding time set down in the Nautical Almanac, to a proportional part to be added to the next preceding distance taken from the Nautical Almanac if the distance be increasing, but subtracted if decreasing: the sum or difference will be the distance at which the quadrant or sextant is to be fixed.

In sweeping for the stars by this method, it will often happen that two or more are swept upon at once: this might cause some difficulty to an inexperienced observer, who would be at a loss to know which to make use of. To remove this, the following description of these stars is added.

ARIETIS.

* α

+ π

+ γ

This star bears about west, distant 23° from the Pleiades or Seven Stars; it is of the second magnitude, and may be known by means of the star π of the third magnitude, situated S. W. from α Arietis at the distance of 3½ degrees. South from the star π at the distance of 1½°, is the star γ, of the fourth magnitude. The northernmost of these stars is α Arietis.

ALDEBARAN.

α γ

+

++

+

About 35° E. from α Arietis, and 14° S. E. from the Pleiades or Seven Stars, is the bright star Aldebaran. Near this star, to the westward, are six or seven stars of the third or fourth magnitude, forming with Aldebaran a figure resembling the letter V, as is represented in the adjoined figure, where Aldebaran is marked α. At the distance of 23° from this star, in a S. E. direction, are three very bright stars, situated in a straight line near to each other, forming the belt of Orion.

LUNAR OBSERVATIONS.

165

The best method of regulating a watch at sea is by taking an altitude of the sun when rising or falling quickly, or when bearing nearly east or west, and noting the time by the watch. With this altitude, the latitude of the place, and the sun's declination, find the apparent time of observation by either of the preceding methods: the difference between this time and that shewn by the watch, will shew how much it is too fast or slow. A single observation taken with care will generally be exact enough: but if greater accuracy is required, the mean of a number of observations may be taken. If the distance of the sun and moon be observed when the sun is three or four points distant from the meridian, the apparent time of observation may be deduced from the altitude of the sun taken at the precise time of measuring the distance: this will render the use of a watch unnecessary, and will prevent any irregularity* in its going, from affecting the result of the observation. If a night observation is to be taken, the watch should be regulated by an altitude of the sun taken the preceding evening, and its going examined by means of another observation taken the next morning: for the time found by an altitude of a star cannot be so well depended upon, except in the morning and evening twilight, as the atmosphere in the night is precarious, and the horizon generally ill defined; but the altitude may be sufficiently exact for finding the correction used in determining the angular distance.

Although all the instruments used in these observations ought to be well adjusted, yet particular care should be taken of the sextant or circle used in measuring the angular distance of the moon from the sun or star, since an error of 1' in this distance will cause an error of nearly 50' in the longitude deduced therefrom. When a great angular distance is to be measured, it is absolutely necessary to use a telescope, and the parallelism of it with respect to the plane of the instrument must be carefully examined: but in measuring small distances the use of the telescope is not of such great importance, and a sight tube may then be used, taking care, however, that the eye and point of contact of the objects on the horizon glass be equally distant from the plane of the instrument. But it ought to be observed that it is always conducive to accuracy to use a telescope, and after a little practice it is easily done.

Whilst one person is observing the distance of the objects, two others ought to be observing the altitudes: and the watch either suspended near one of the observers, or put into the hands of a fourth person appointed to note the times; the observer, who takes the angular distance, giving previous notice to the others to be ready with their altitudes by the time he has finished his observation, which being done, the time, altitudes, and distance† should be carefully noted, and other sets of observations taken, which must be done within the space of 15 minutes, and the mean of all these observations must be taken and worked as a single one.

When a ship is close hauled to the wind, with a large sea, or when sailing before the wind, and rolling considerably, it is difficult to measure the distance of the objects: but when the wind is enough upon the quarter to keep the ship steady, there is no difficulty, especially in small distances, which are much more easily measured than large ones, and are not so liable to error from an ill adjustment of the telescope: an observer would therefore do well to choose those times for observation, when the distance of the objects is less than 70° or 80°. An observation of the sun and moon is generally much easier to take when the altitude of the moon is less than that of the sun, because the instrument will be held in a more natural and easy manner. When the moon is near the zenith, the observation is generally difficult to take, and liable to be erroneous, because the observer is forced to place himself in a disagreeable posture. For the same reason, an observation of the moon and

* It is not uncommon to find a difference in the regulation of a watch in the forenoon and afternoon; this difference generally arises from the irregularity in the going of the watch.
† If the distances are measured by a circular instrument, it will not be necessary to note the several distances measured, but only the times and altitudes, as the sum of all the distances measured by the circle will be given by the instrument at the end of the observations, and if the altitudes of the objects also measured by circular instruments, it will not be necessary to note the several altitudes, but only the times of observation.

a star is generally much easier to take when the star is lower than the sun. This situation of the objects may in most cases be obtained by taking the observation at a proper time of the day. But it must be observed that neither of the objects ought to be at a less altitude than 10° , upon account of the uncertainty of the refraction near the horizon; for the horizontal refraction varies from $33'$ to $36' 40''$ only by an alteration of 40° in the thermometer. This alteration might cause an error of two degrees in the longitude.

In taking the altitude of the moon, the round limb, whether it be upper or lower, must be brought to the horizon. In damp weather it is difficult to observe the altitude of the stars, on account of their dimness, particularly α Pegasi and α Arietis. Sometimes they are so dim that they cannot be seen through the holes of the sight vane of a quadrant, particularly if the mirrors are not well silvered; in this case the vane must be turned round and the eye held in nearly the same place, or the altitude must be taken with a sextant furnished with a sight tube.

We have here supposed that there were observers enough to measure the altitudes when the distance was observed; but if that is not the case, the altitudes may be estimated by either of the methods which will be hereafter given.

Preparations necessary for working a Lunar Observation.

Find the apparent time of observation by astronomical account, reckoning from noon to noon in numerical succession from 1 to 24, and taking the day of the month as by the sea account; to this time apply the longitude turned into time by Table I. by adding if in west longitude, but subtracting if in east; the sum or difference will be the supposed time at Greenwich or *reduced time*.

In page VII. of the month of the Nautical Almanac, find the moon's semi-diameter and horizontal parallax, for the nearest noon and midnight before and after the time, and find the difference of the parallaxes and the difference of the semi-diameters; then enter Table XI. with these differences respectively in the side column under reduced time at the top, opposite the former and under the latter, will stand the corrections to be applied respectively to the semi-diameter and horizontal parallax; first in the Nautical Almanac, additive if increasing, subtractive if decreasing; the sum or difference will be the horizontal semi-diameter and the *horizontal parallax* respectively, at the time of observation. To this horizontal semi-diameter, must be added the augmentation from Table XV. corresponding to the moon's altitude, the sum will be the *true semi-diameter* of the moon.

The sun's true semi-diameter is to be found in page III. of the month of the Nautical Almanac.

To the observed altitude of the sun's or moon's lower limb add $12'$, but if the upper limb was observed, subtract $20'$, and from the star's observed altitude subtract the semi-diameter of the star; you will have nearly the *apparent altitudes* of those objects respectively.

To the *observed distance of the moon from a star*, add the moon's true semi-diameter if her nearest limb was observed, but subtract that semi-diameter if her farthest limb was observed; the sum or difference will be the *apparent distance*. But to the *observed distance*

* Or by multiplying by 4 sexagesimally, in the manner directed in the note, page 124.

† When the sum exceeds 24 hours, you must subtract 24 hours and add one to the day of the month; and when the time to be subtracted is greater than the apparent time, the latter must be increased by 24 hours, and one day taken from the day of the month, conformable to the usual rules of addition and subtraction. If the chronometer used in taking the observation be regulated to Greenwich time, part of the calculation will be unnecessary, because the reduced time at Greenwich will be given by the chronometer.

‡ These corrections may be found easily without the table, by saying, as 12 hours are to the semi-diameter, so is the difference of semi-diameter or parallax to the corresponding correction. If the reduced time cannot be found accurately in the table, must use the nearest numbers which will in general be sufficiently accurate.

§ These altitudes are supposed to be taken at sea by a fore-observation; and the application of the above numbers will give the apparent altitudes corresponding to observations taken on the common sized vessel (where the dip is about $4'$ or $5'$) to a sufficient degree of accuracy; if the vessel was 40 or 50 feet above the water, $1'$ or $2'$ might be taken from these altitudes. The propriety of these numbers will appear by considering that every wave, by raising the ship above the level of the sea, will alter the dip, and that an error of $1'$ or $2'$ in the altitudes, will in general cause but a small error in the result of the calculation of a lunar observation, so that for all practical purposes the above altitudes may be esteemed as sufficiently exact. It may also be observed, that the error arising from neglecting the refraction will not generally be greater than that arising from neglecting the equations depending on the spheroidal form of the earth, and on the density and temperature of the air; equations which are almost always neglected.

If any one wishes to obtain the apparent altitudes strictly, he must, from the observed altitude of the object, subtract the dip of the horizon taken from Table XIII. and add or subtract the semi-diameter of the object according as the lower or upper limb was observed.

lance of the sun and moon's nearest limbs, add their true semi-diameters ; the sum will be the apparent distance.

These preparations are necessary in every method of working a lunar observation. The most noted methods are those of Dunthorne, Borda, Maskelyne, Rios, Witchell, Lyons, &c. and improvements thereon by various authors.

Dunthorne's and similar methods, have one great advantage, in not being liable to a variety of cases ; but those methods are tedious, when tables of logarithms to minutes only are used, by reason of the great exactness required in proportioning the logarithms to seconds. This is obviated in the excellent methods published by Rios and Stansbury, but they require large and expensive tables, and on that account are not in very general use. Witchell's and Lyon's methods do not labour under the inconvenience of requiring large tables, nor do they require any particular notice of the seconds in finding the log. sines and log. tangents, but these methods are embarrassed with a variety of cases : sometimes the corrections are additive, sometimes subtractive, and learners find a difficulty in rightly applying them. To remedy this, a method was published in the first edition of this work, in which two corrections were constantly additive, two subtractive, and one small correction was additive, when the distance was less than 90° , but subtractive when above 90° .

This method was further improved in the Appendix to that edition, by means of four new Tables, which are inserted in this edition, and numbered XVII. XVIII. XIX. and XX. by means of which the work is considerably shortened, and all the corrections rendered additive. This method will now be given, after making a few remarks on the manner of taking the corrections and logarithms from these new Tables.

Tables XVII. contains a correction and logarithm to be used when the moon's distance from a star is observed, and Table XVIII. is a similar one, to be used when the moon's distance from the sun is observed. Both these Tables are so extended, that no proportional parts are necessary in taking out the corrections and logarithms, except the altitude of the Sun or Star is less than $7^\circ 30'$, and at such altitudes an observation is liable to error on account of the uncertainty of the refraction : so that, in using these tables, it is sufficiently accurate to find the number nearest to the given altitude of the sun or star, and make use of the corresponding correction and logarithm. Thus if the star's altitude is $12^\circ 25'$, the nearest number in Table XVII. is $12^\circ 24'$, corresponding to which are correction $55' 45''$, and logarithm 1.3161.

Table XIX. contains the corrections and logarithms corresponding to the moon's horizontal parallax and altitude, both being found at the same opening of the book. The corrections for seconds of parallax and minutes of altitude, are easily taken out by means of Tables A, B, C, placed in the margin. The method of finding these corrections is given at the bottom of the Table ; they are always additive.

Besides the two logarithms taken from Table XVII. (or XVIII.) and XIX. this new rule requires only four logarithms to be taken from Table XXVII. to four places of figures, and to the nearest minute, it being in general unnecessary to proportion for the seconds.

We shall now give the rule for correcting the distance, and shall, for brevity, use the word sine, secant, and co-secant, instead of log. sine, log. secant, and log. co-secant respectively, and the same will be observed in the second and third methods of correcting the distance.

*Shortest method of correcting the Apparent Distance of the Moon from the Sun.**

Add the apparent distance of the moon from the sun, to their apparent altitudes, and note the half sum. The difference between the half sum and the apparent distance, call the first remainder ; and the difference between the half sum and the sun's apparent altitude, call the second remainder.

Take from Table XXVII. the following logarithms, which mark beneath each other in columns, viz. the sine of the apparent distance to be marked in both columns, the secant of the second remainder to be marked also in both columns, the secant of the first remainder to be placed in the first column, and the secant of the half sum in the second column.†

Enter Table XVIII. (or Table XVII. if a star was used) and take out the correction corresponding to the sun's altitude (or star's :) take also from the same Table the corresponding logarithm, which place in column 1st.

Enter Table XIX. with the moon's apparent altitude and horizontal parallax, find the corresponding correction, which place under the former correction, and the logarithm, which place in column 2d.

This rule is the same as that for correcting the distance of the moon from a star, except in reading for sun, and using Table XVII. instead of Table XVIII. If the distance of the moon from a planet is sought, its parallax may generally be neglected, considering it as a fixed star, and using Table XVII. However, if the planet's horizontal parallax is known, the corresponding correction of the distance may be found nearly as follows :

Add together the 1st correction and the cor. Tab. XVII. call the sum S. Take the difference between S and $60''$ and to its prop. log. add the prop. log. of double of the planet's horizontal parallax, and the arithmetical complement of the log. found in Table XVII. the sum (rejecting 10 in the index) will be prop. log. of the sought correction, which is to be added to the computed distance if S is less than $60''$, subtracted if S exceed $60''$. See note page 129 for an example of this rule. Rejecting always the tens in the index.

LUNAR OBSERVATIONS.

169

To find the true distance.

	Col. 1st.	Col. 2d.	
App. Dist. $47^{\circ} 34'$	size 9.8681	same 9.8681	App. Dist. less $2^{\circ} 45'$ $53^{\circ} 48'$
* App. Alt. $80^{\circ} 31'$	2 Rem. $53^{\circ} 53'$ co-ss 0.2531	same 0.2531	Table XVII. $59^{\circ} 14'$
App. Alt. $70^{\circ} 47'$	1 Rem. $36^{\circ} 52'$ sec. 0.0869	sum $84^{\circ} 26'$ sec. 1.0132	Table XIX.† $42^{\circ} 03'$
Sum $168^{\circ} 52'$	Table XVII. log. 1.8676	Table XIX. log. * 2.569	Cor. 1. $1^{\circ} 29'$
Sum $84^{\circ} 26'$	1 Cor. $1^{\circ} 29'$ P. L. 2.0260	2 Cor. $7^{\circ} 50'$ P. L. 1.9316	Table XX. $7^{\circ} 50'$
App. Dist. $47^{\circ} 34'$			True distance $47^{\circ} 24' 49''$
1st Rem. $36^{\circ} 52'$			
Sum $84^{\circ} 26'$			
* App. Alt. $80^{\circ} 31'$			
2d Rem. $33^{\circ} 53'$			

To find the longitude.

True distance	$47^{\circ} 24' 49''$	
Dist. by N. A. at 3h.	$46^{\circ} 56' 11''$	
Difference	$29^{\circ} 38'$	P. L. 7934
Dist. by N. A. at 3h.	$46^{\circ} 56' 11''$	
at 6h.	$43^{\circ} 23' 59''$	
Difference	$1^{\circ} 27' 48''$	P. L. 3118
	$0^{\circ} 58' 42''$	P. L. 4566
	add 3	
Time at Greenwich.....	$3^{\circ} 58' 42''$	
Time at ship	$18^{\circ} 6'$	
Longitude in time	$8^{\circ} 7' 18'' = 121^{\circ} 49' \text{ E. from Greenwich.}$	

EXAMPLE II.

Suppose that on the 20th September, 1820, sea account, at 7h. $23' 45''$, apparent time, in the longitude of $166^{\circ} 30' \text{ W.}$ by account, the observed distance of the nearest limb of the moon from the star Antares was $10^{\circ} 17' 10''$, the observed altitude of the star $12^{\circ} 34'$, and the observed altitude of the moon's lower limb $20^{\circ} 26'$. Required the true longitude?

Preparation.

Sea account Sept. 20, is by the N. A. Sept. 19d. 7h. $23' 45''$.
Long. $166^{\circ} 30' \text{ W.}$ in time $11^{\circ} 6'$

Reduced time Sept. 19	$18^{\circ} 29' 45''$	* obs. alt. $12^{\circ} 34'$
		sub. $4'$
S. D. Sept. 19, midn. $16^{\circ} 55'$	hor. par. Sept. 19, midn. $60' 47''$	* app. alt. $12^{\circ} 50'$
Sept. 20, noon $15^{\circ} 40'$	Sept. 20, noon $61^{\circ} 3'$	obs. alt. L. L. $20^{\circ} 26'$
Difference $5'$	Difference $16'$	add $12'$
Table XI. $3'$	Table XI. $9'$	App. Alt. $20^{\circ} 38'$
Sum $16^{\circ} 38'$	hor. par. $60^{\circ} 56'$	Obs. Dist. D * N. L. $21^{\circ} 03' 18''$
Aug. Table XV. $5'$		D S. D. $18^{\circ} 43'$
S. D. $16^{\circ} 43'$		App. Dist. D * $31^{\circ} 20' 1''$

* Tab. Log = Log. Table XIX. 2260 + Log. Table C 9 = 2269.

This Corr = Corr. Table XIX. $41' 49''$ + Corr. Table A $13''$ + Corr. Table B $6'' = 42' 05''$.

If in this case the object, instead of being the fixed star Antares, had been a planet, whose horizontal parallax is $20''$, the correction of distance arising from this parallax, might be found by the rule in the note 167. Thus, the sum of the Corr. Tab. XVII. ($56' 14''$) and Cor. 1 ($1' 29''$) is $57' 43''$. Rejecting $60'$ Prop. log. of the remainder $0' 43''$ is 2.4000, the prop. log. of the double horizontal par. $40''$ is 2.4314. arith. comp. log. Table XVII. is 8.1324. The sum of these three logs. (rejecting 10 in the index) is equal to the prop. log. of $12''$ the required correction, subtractive from $47^{\circ} 24' 49''$ above found, and it would therefore become $47^{\circ} 21' 57''$.

LUNAR OBSERVATIONS.

To find the true distance.

App. Dist.	81 20	size	9.9950	same	9.9950	App. Dist. less $\frac{2}{2} = 79$	20 01
* App. Alt.	12 30	2 Rem. 44° 44' Co-ss	0.1525	same	0.1525	Table XVII.	55 47
App. Alt.	20 50	1 Rem. 24 06 Sec.	0.0398	sum 57° 14' Sec.	0.2883	Table XIX.†	5 09
Sum	114 28	Table XVII. Log.	1.3194	Table XIX. Log.*	.1888	Cor. 1	5 36
Sum	57 14	1 Cor. 5' 36" P. L.	1.5065	2 Cor. 44' 55" P. L.	6029	Cor. 2	44 55
1 Rem.	24 6					Table XX.	23
2 Rem.	44 44					True distance	81 11 51

To find the longitude.

True distance.....	81 11 51	
Dist. by N. A. at 18h.	80 57 28	
Difference	14 23	P. L. 1.0974
Dist. by N. A. at 18h.....	80 57 28	
at 21h.....	82 50 17	
Difference	1 52 49	P. L. 2029
	0 22 57	P. L. 8945
Add.....	18	
Time at Greenwich	18 22 57	
Time at ship	7 23 45	
Longitude in time	10 59 12=164° 48' W.	

EXAMPLE III.

Suppose on April 25th 1820, at 2h. A. M. sea account, in the longitude of 166° E. by account, the observed distance of the moon's farthest limb from Antares was 76° 32' 15", the observed altitude of the star 23° 34', the observed altitude of the moon's lower limb 17° 59'. Required the true longitude?

Preparation.

Sea account April 25, or by N. A. April 24th		14h. 0'			
Long. 166° E.		11' 4			
Reduced time		April 24th			
		2 56			
D's S. D. April 24, noon	14' 51''	D's Hor. Par. noon	54' 23''	* Obs. Alt.	23° 34'
midn.	14 53	midn.	54 31	sub.	4
Difference	2	Difference	8	* App. Alt.	23 30
Table XI.	0	Table XI.	2	D Obs. Alt. L. L.	17 59
Sum	14 51	D Hor. Par.	54 25	add	12
Aug. Tab. XV.	5			D App. Alt.	18 11
Sub. D S. D.	14 56			Obs. Dist.	76° 32' 15''
				Sub. D S. D.	14 56
				App. Dist.	76 17 59

To find the true distance.

App. Dist.	76 17	Col. 1st.	9.9874	same	9.9874	App. Dist. less $\frac{2}{2} = 74$	17 19
* Ap. Alt.	23 30	2 Rem. 35° 29' co-ss	0.2362	same	0.2362	Table XVII.	57 59
D Ap. Alt.	18 11	1 Rem. 17° 18' sec.	0.0201	sum 58° 59' sec.	0.2879	Table XIX.‡	10 51
Sum	117 58	Table XVII. log.	1.5784	Table XIX. log.†	2452	1 Cor.	2 42
Sum	58 59	1 Cor. 2' 42" P. L.	1.3231	2 Cor. 31' 40" P. L.	0.7547	2 Cor.	51 46
1 Rem.	17 18					Table XX.	23
2 Rem.	35 29					True distance	76 08 45

* This Log=Log. Table XIX. 1883+Corr. Table C 5=1888.

† This Corr=Corr. Table XIX. 5' 5" +Corr. Table A 2' +Corr. Table B 2'=5' 9".

‡ This Log=Log. Table XIX. 2428+Corr. Tab. C 6=2432.

§ This Corr=Corr. Table XIX. 10' 19" +Corr. Tab. A 32' +Corr. Tab. B 0'=10' 51'.

LUNAR OBSERVATIONS.

171

To find the true longitude.

True distance	76° 00' 45"	{	Difference 0° 0' 12'	P. L. 2.9542	
By N. A. distance at 3h.	76 00 57			Difference 1 29 59	P. L. 3011
6h.	74 30 58				
			0h. 0' 24"	P. L. 2.6531	
	add		3		
Time at Greenwich	3	0	24		
Time at Ship			14		
Difference is long. in time	10	59	36=164° 54'	E. from Greenwich.	

EXAMPLE IV.

Suppose that on the 31st October, 1820, sea account, at about 1h. P. M. in the longitude of 75° W. by account, the following observations of the sun and moon were taken. Required the true longitude?

Preparation.

Time per watch.	Observed distance. ☉ ☾ N. L.	Observed Alt. ☉ L. L.	Observed Alt. ☾ L. L.
0h. 58' 5"	69° 43' 49"	45° 57'	17° 18'
0 59 8	43 18	59	17 9
1 0 10	42 47	48	16 59
1 1 4	42 20	44	16 48
1 1 53	41 56	39	16 36
5) 5 0 20	14 10	240	84 50
1 0 4	68 42 50	45 48	16 58
App. time	☉ S. D. 16 9	add 12	add 12
	☾ S. D. 14 53		
	69 13 52	46 0	17 10
	App. Dist.	App. Alt. ☉	App. Alt. ☾

Sea account 31 Oct. or N. A. Oct. 30d. 1h. 0' 4"
Long. 75° W. 5

Reduced time Oct.	30d. 6h. nearly.
☾ S. D. Oct. 30, noon 14' 50"	☾ Hor. Par. Oct. 30, noon 54' 21"
midnight.. 14 48	midn. 54 13
Difference 2	Difference 8
Table XI. 1	Table XI. 4
14 49	
Aug. Table XV. 4	☾ Hor. Par. 54 17
☾ S. D. 14 53	

To find the true distance.

App. Dist.	69 14	sine	9.9702	same	9.9702	App. Dist. less 2=67	13 52
☉ App. Alt.	45 02	Rem. 29° 12' co-s.	0.4612	same	0.4612	Table XVIII.	50 11
☾ App. Alt.	17 10	Rem. 3 2 sec.	0.0005	sum 66 12 sec.	0.5041	Table XIX. †	10 52
		Table XVII. log.	1.8942	Table XIX. log.*	2.4071	1 Cor.	52
Sum	132 24					2 Cor.	15 14
☉ Sum	66 12	Cor. 52' P. L.	2.3180	2 Cor. 15' 14" P. L.	1.0726	Table XX.	22
☾ Sum	3 2						
3 Rem.	20 12					True distance	63 40 23

* This Log=Log. Tab. XIX. 2454+Cor. Tab. C 2=2457.

† This Corr.=Corr. Tab. XIX. 10' 12'+Corr. Tab. A 40'+Corr. Tab. B 0'=10' 52'.

LUNAR OBSERVATIONS.

To find the true longitude.

True distance	68° 40' 23"	}	Difference	0° 0' 6"	P. L.	3.9552
By N. A. Dist. at 6h.	68 40. 29		Difference	1 21 18	P. L.	3452
By N. A. Dist. at 9h.	67 19 11					
			0h. 0' 13"	P. L.	2.9101	
	add		6			
Time at Greenwich	.....		6	0	13	
Time at Ship	.....		1	0	4	
Difference is long. in time	5		0	9	= 75° 2' W. from Greenwich.	

EXAMPLE V.

Suppose that on the 5th May, 1820, sea account, at about 4h. 4' P. M. in the latitude of 50° 1' S. and in the longitude of 1° E. by account, the following observations of the sun and moon were taken. Required the true longitude?

Preparation.

	Observed Dist. ☉ D N. L.	Observed Alt. ☉ L. L.	Observed Alt. D's U. L.
	101° 42' 35"	14° 53'	41° 58'
	41 39	15 21	34
	40 22	15 49	4
Sun's	3) 124 27	46 3	96
Mean	101 41 29	15 21	41 32
Index errors	— 3	— 3	+ 8
Cor. Index errors	101 41 26	15 18	41 40
	☉ S. D. 15 52	add 12	sub. 20
	D S. D. 16 14		
	102 13 32	15 30	41 20
	App. Dist.	☉ App. Alt.	D App. Alt.

Sea account, May 5, or N. A. May 4d. 4h. 4'
Longitude 1° E. 4

Reduced time		May 4d. 4h.	
D S. D. May 4, noon	16' 3"	D Hor. Par. noon	58' 46"
midnight	16 6	midnight	59 58
<hr/>		<hr/>	
Difference	3	Difference	10
Table XI.	1	Table XI.	3
<hr/>		<hr/>	
	16 4	D Hor. Par.	58 51
Aug. Table XV.	10		
<hr/>			
D S. D.	16 14		

To find the true distance.

App. Dist.	102 14	sine	9.9900	same	9.9900	Ap. Dis. less 100	13
☉ App. Alt.	15 30	2 Rem. 64° 2' co-se.	0.0462	same	0.0462	Table XVIII.	58
D App. Alt.	41 20	1 Rem. 22 42 sec.	0.0330	sum 78° 52' sec.	0.7407	Table XIX.	18
		Table XVIII. log.	1.4267	Table XIX. log.	1951	1st. Cor.	5
Sum	149 4					2d. Cor.	19
1/2 Sum	74 32	1 Cor. 5' 43" P. L.	1.4973	2 Cor. 19' 12" P. L.	.9720	Table XX.	
1st. Rem.	22 43						
2d. Rem.	64 2						
						True distance	101 52 - 2

LUNAR OBSERVATIONS.

173

To find the apparent time and true longitude.

Correct Altitude	15° 21'	True distance	101° 52' 3
Lat. of Ship	30 1 secant	By N. A. dist. at Sh.	102 35 6
Polar Distance	105 4 co-secant		
Sum	131 32	Difference	83 3 P. L. 7381
Half Sum	65 46 co-sine	By N. A. dist. at Sh.	102 26 6
Half Sum—Altitude	60 12 sine	Sh	100 47 39
Sum	213.62940	Difference	1 37 27 P. L. 2535
Apparent time 4h. 5' 52"	sine	add	1h. 1' 3" P. L. 6895
	3.70473		
		Time at Greenwich	4 1 3
		Time at Ship	4 3 32
		Longitude in time	2 22=0° 37' E. from [Greenwich].

EXAMPLE VI.

Suppose that on the 8th of February, 1820, sea account, at about 8h. 36' A. M. in the longitude of 21° W. from Greenwich by account, six distances of the sun and moon's nearest limbs were observed by a circle of reflection to be 464° 10' 12" the corresponding times and altitudes being as in the following Table. Required the true longitude?

Preparation.

Apparent time per watch, A. M.	Observed distance ☉ ☽ N. L.	Observed Alt. ☉ L. L.	Observed Alt. ☽ U. L.
8h. 33' 24"	Sum of the distances taken from the circle at the end of the observations.	34° 1'	61° 47'
34 36		34 13	61 36
35 18		34 21	61 27
36 36		34 31	61 17
37 4		34 39	61 9
39 2		35	60 45
6) 36 0	464° 10' 12"	206 48	368 0
8 36 0	77 21 42	34 28	61 20
App. time	☉ S. D. 16 14 ☽ S. D. 15 56	add 12	sub. 20
	77 53 52	34 40	61 0
	App. Dist.	☉ App. Alt.	☽ App. Alt.

Feb. 8, sea account, or by N. A. Feb.
Long. 21° W.

7d. 20h. 36'
1 24

Reduced time Feb

7d. 22h.

D's S. D. Feb. 7, midnight	15' 36"
Feb. 8, noon	15 43
Difference	7
Table XI.	6
	15 43
Aug. Tab. XV.	14
D's S. D.	15 56

D's Hor. Par. Feb. 7, midnight	57' 9"
Feb. 8, noon	57 37
Difference	28
Table XI.	23
D's Hor. Par.	57 32

To find the true distance.

App. Dist.	77 54	alt	0.9905	same	0.9905	Ap. Dist. less 2=75	63 52
☉ App. Alt.	34 40	Rem. 82° 7' co-sec.	0.1023	same	0.1023	Table XVIII.	54 44
☽ App. Alt.	61 0	Rem. 83 53 sec.	0.0052	sum 38° 47' sec.	1.2327	Table XIX.	32 20
		Tab XVIII Log.	1.7702	Table XIX Log.	2025	1st. Cor.	2 26
		Cor. 2 25" P. L.	1.0684	Cor 5 7 P. L.	1.5454	2d. Cor.	6 7
						Table XX.	18
						True distance	77 32 47

The correct altitude is found by subtracting the refraction 5 from the apparent altitude 15° 50'.
The Polar Distance is found by adding the Declination 16° 4' N. (corresponding to the reduced time) to 90°.
This log.—Log. Table XIX. 3016 + Log. Tab. C 9=2025
This Corr.—Corr. Table XIX. 3. 7 + Corr. Tab. A 71 + Corr. Tab. B 0= 72 20

To find the true longitude.

True distance	77° 32' 47"	}	Difference	0° 30' 54"	P. L.	7653
By N. A. Dist. Feb. 7, 21h.	78 3 41		Difference	1 38 9	P. L.	2908
Feb. 8, 0h.	76 31 32					
			add	1h. 0' 22"	P. L.	4745
				21		
Time at Greenwich				22 0 22		
Time at Ship				20 36		
Diff. is Long. in time				1 24		
				22=21° 5' W. from Greenwich.		

Second method of finding the true distance of the Moon from the Sun or a Star.

From the sun's refraction (Table XII.) take his parallax in altitude (Table XIV.) the remainder will be the correction of the sun's altitude.

The star's refraction (Table XII.) is the correction of its altitude.

From the proportional logarithm of the moon's Horizontal Parallax* increasing the index by 10, take the sine of the moon's apparent zenith distance (Table XXVII.) the remainder will be the prop. log. of the parallax in altitude, which must be found in Table XXII. and the moon's refraction (Table XII.) subtracted therefrom, the remainder will be the correction of the moon's altitude.†

Add together the apparent distance of the sun and moon (or star and moon) and their apparent zenith distances (or complement of their apparent altitudes) and note the half sum of these numbers: the difference between the half sum and the moon's apparent zenith distance call the *first remainder*; and the difference between the half sum and the sun's (or star's) apparent zenith distance call the *second remainder*.

To the constant log. 9.6990 add the co-secant of the half sum and the sine of the apparent distance (both taken from Table XXVII.) the sum, rejecting 20 from the index, will be a *reserved logarithm*.

To the reserved logarithm add the sine of the sun's (or star's) apparent zenith distance, the co-secant of the first remainder (both taken from Table XXVII.) and the prop. log. of the correction of the sun's (or star's) altitude (Table XXII.) the sum, rejecting 30 from the index, will be the prop. log. of the *first correction* to be found in Table XXII.

To the reserved logarithm add the sine of the moon's apparent zenith distance, the co-secant of the second remainder (Table XXVII.) and the prop. log. of the correction of the moon's altitude (Table XXII.) the sum, rejecting 30 from the index, will be the prop. log. of the *second correction*, to be found in Table XXII.

Then to the apparent distance add the correction of the moon's altitude, and the first correction, and subtract the sum of the second correction and the correction of the sun's altitude, the remainder will be the corrected distance.

Add 60' to the correction of the moon's altitude, and 60' to the difference between the correction of the moon's altitude and the second correction; find both these sums in the side column of Table XX. and in either of the vertical columns, under the corrected distance, find the seconds corresponding,‡ the difference of these two numbers will be a number of seconds to be added to the corrected distance when less than 90°, but subtracted when above 90°, the sum or difference will be the true distance.

* Instead of finding the moon's horizontal parallax from the Nautical Almanac, we may find the proportional logarithm thereof in the same page of the month of that work. Thus if we would work Example III. preceding, by this rule, we might take out the logs. 5193 and 5187, instead of the Hor. Par. 54' 28" and 54' 31", and obtain by means of Table XI. the sought log. 5195 without referring to Table XXII.

† All these corrections may be found by means of Tables XVII. XVIII. and XIX. Thus the correction of Table XVII. subtracted from 60 minutes, will give the correction of the star's altitude. The correction of Table XVIII. subtracted from 60 minutes, will give the correction of the sun's altitude. The correction of Table XIX. subtracted from 59' 42" will give the correction of the moon's altitude. Perhaps the use of these Tables in this and in the following method, would not be inconvenient.

‡ This logarithm was found before, in calculating the correction of the moon's altitude.

§ Observing to take both numbers from the same vertical column. It may be observed that the numbers in one of the columns of Table XX. of this collection, are the same as those of Table XIX. of edition 1, and the numbers in the other column differ 18" from the former; but the numbers in the column of Table XIX. differ 60' from those in Table XX. so that in using Table XIX. edition 1st, it is unnecessary to add 60' to the correction of the moon's altitude and the first correction; this renders that Table rather more convenient in this second method, than Table XX. of this collection.

LUNAR OBSERVATIONS.

175

EXAMPLE—(the same as Example I. preceding.)

Suppose the apparent distance of the centre of the moon from the star Aldebaran was $47^{\circ} 33' 48''$, the apparent altitude of the star $50^{\circ} 31'$, the apparent altitude of the moon's centre $70^{\circ} 47'$, and the proportional logarithm of the moon's horizontal parallax 5199. Required the true distance of the moon from the star?

App. Alt.	$70^{\circ} 47'$	* Ap. Alt.	$50^{\circ} 31'$	Hor. Par. P. Log.	10.5189	
Zen. Dist.	$19^{\circ} 13'$	* Zen. Dist.	$39^{\circ} 29'$	Z. D. $19^{\circ} 13'$ sine	9.5174	* Refrac. $47''$
				$17^{\circ} 54''$ P. L.	1.0025	
				Refraction	20	
				Cor. App. Alt.	$17^{\circ} 34'$	
App. Dist.	$47^{\circ} 34'$	Constant log.		9.6890		
Zen. Dist.	$19^{\circ} 13'$	Sum $58^{\circ} 8'$ co-sec.		10.0869		
* Zen. Dist.	$39^{\circ} 29'$	Dist. $47^{\circ} 34'$ sine		9.8681		
Sum	$108^{\circ} 16'$	Reserved Log.		9.6840	Reserved Log.	9.6840
Sum	$58^{\circ} 8'$	* Zen. Dist. $39^{\circ} 29'$ sine		9.8034	Zen. Dist. $19^{\circ} 13'$ sine	9.5174
Zen. Dist.	$19^{\circ} 13'$	1 Rem. $53^{\circ} 55'$ co-sec.		0.2584	2d. Rem. $13^{\circ} 39'$ co-sec.	0.0271
1st Rem.	$53^{\circ} 55'$	* Cor. $0^{\circ} 47'$ P. L.		2.3618	Cor. $17^{\circ} 34''$ P. L.	1.0106
Half sum	$58^{\circ} 8'$	1 Cor. $1^{\circ} 29'$ P. L.		2.0821	2d. Cor. $27^{\circ} 18'$ P. L.	0.8171
* Zen. Dist.	$39^{\circ} 29'$					
2d. Rem.	$13^{\circ} 39'$	Apparent distance		$47^{\circ} 33' 48''$		
		Add { First Correction		$1^{\circ} 29'$		
		Cor. App. Alt.		$17^{\circ} 34'$		
		Sub. { 2d. Cor. $27^{\circ} 18''$ }		$47^{\circ} 52' 51''$		
		Cor. * App. Alt. $47'$ }		$28^{\circ} 5'$		
		Corrected distance		$47^{\circ} 24' 46''$		
		Correction Table XX.		1		
		True distance		$47^{\circ} 24' 47''$	differing $2''$ from the former method.	

We shall now give a third method of correcting the apparent distance, being an improvement on Witchell's method, which was published in the former edition of this work. This improvement was made in consequence of a suggestion from a gentleman eminently distinguished for his mathematical acquirements,* that, by a small variation in the calculation, the number of cases might be lessened: and, upon examination, it was found that by making other alterations, the number of cases might be farther decreased, and the manner of applying the corrections rendered more simple. The method thus improved is as follows.

Third method of finding the true distance of the Moon from the Sun or Star.

From the sun's refraction (Table XII.) take his parallax in altitude (Table XIV.) the remainder will be the correction of the sun's altitude.

The star's refraction is the correction of its altitude.

From the proportional logarithm of the moon's horizontal parallax, increasing the index by 10, take the co-sine of the moon's apparent altitude (Table XXVII.) the remainder will be the proportional logarithm of the moon's parallax in altitude; from which, subtracting the moon's refraction (Table XII.) the remainder will be the correction of the moon's altitude.†

1. Add together the apparent altitudes of the moon and sun (or star) and take the half sum; subtract the lesser altitude from the greater, and take the half difference; then add together

The tangent of the half sum,

The co-tangent of the half difference,

The tangent of half the apparent distance.

The sum, rejecting 20 in the index, will be the tangent of the angle A, which must be sought for in Table XXVII. and taken out less than 90° when the sun's altitude is less than the moon's, otherwise greater than 90° .‡ The difference of the angle A,

* The late Chief Justice Parsons.

† These corrections may be found by Tables XVII. XVIII. XIX. as was shown in the note to the second method, page 174.

‡ Every co-tangent in Table XXVII. corresponds to two angles, one greater than 90° , the other less.

and half the apparent distance, is to be called the *first angle*, and their sum the *second angle*.

2. Add together the tangent of the first angle.

The co-tangent of the sun or star's apparent altitude.

The prop. log. of the correction of the sun or star's altitude.

The sum, rejecting 20 in the index, will be the prop. log. of the *first correction*.

Or the refraction (Table XII.) corresponding to the first angle or its supplement, will be the first correction nearly; particularly if the altitude of the sun or star be great, and the first angle be near 90° .

3. Add together, the tangent of the second angle,

The co-tangent of the moon's apparent altitude,

The prop. log. of the correction of the moon's altitude,

The sum, rejecting 20 in the index, will be the prop. log. of the *second correction*.

4. The first correction is to be added to the apparent distance when the first angle is less than 90° , otherwise subtracted; and in the same manner the second correction is to be added when the second angle is less than 90° , otherwise subtracted. By applying these two corrections, we shall obtain the corrected distance or *third angle*.

5. Add $60'$ to the correction of the moon's altitude and to the second correction; find both these numbers in the side column of Table XX. and in either of the vertical columns,* under the third angle, find the numbers corresponding; the difference of these two numbers will be a number of seconds to be added to the third angle when less than 90° , but subtracted when above 90° , the sum or difference will be the true distance.

Thus it appears that the first, second and third corrections, depend on the first, second and third angles respectively; if either of those angles be less than 90° the corresponding correction will be additive: but if more than 90° , subtractive. This rule being uniform for applying all three corrections, makes it more easy to be remembered.

EXAMPLE—(the same as Example I. preceding.)

Suppose the apparent distance of the centre of the moon from the star Aldebaran was $47^\circ 33' 49''$, the apparent altitude of the star $50^\circ 31'$, the apparent altitude of the moon's centre $70^\circ 47'$, and the proportional logarithm of the moon's horizontal parallax 5199. Required the true distance of the centre of the moon from the star?

D App. Alt. $70^\circ 47'$
* App. Alt. $50^\circ 31'$

Sum . . 121 18 Half Sum $60^\circ 39'$ tan. 10.25002

Diff. . . 20 16 Half Diff. 10 8 co-t. 10.74721
Half Dist. 23 47 tan. 9.64415
Angle A 77 0 tan. 10.64102

Differ. is 1st Angle 53 22 tan. 10.1287
* App. Alt. $50^\circ 31'$ co-t. 9.9158
Cor. * Alt. 47'' P. L. 2.5613

First Corr. 42 P. L. 2.4058

Sum is second Angle 100 56 tan. 10.7140
D App. Alt. $70^\circ 47'$ co-t. 9.5423
Cor. D Alt. $17^\circ 31'$ P. L. 1.0106

Second cor. 9 41 P. L. 1.2853

Hor. Par. P. L. 10.5199
D App. Alt. $70^\circ 47'$ cor. 9.5174 * Ref. 47

17' 54'' P. L. 1.0023

20 D Refraction

17 54 cor. D Alt.
Apparent Distance $47^\circ 33' 49''$
1st cor. add . . 42

2d cor. sub. . . 9 41

3d Angle . . . $47^\circ 24' 46''$
3d cor. . . 1

True distance . . . $47^\circ 24' 47''$
Diff. 2'' from the former method.

If the star's altitude had been greater than the moon's, the angle A would have been $102^\circ 51'$. The first angle in this example is $53^\circ 22'$ and the refraction (Table XII.) corresponding, is $13''$, which is nearly equal to the first correction.

Method of taking a Lunar Observation by one observer.

Three observers are required to make the necessary observations for determining the longitude; one to measure the distance of the bodies, and the others to take the altitudes. In case of not having a sufficient number of instruments or observer

* Both numbers must be taken from the same vertical column, as was observed in the note to the second method, and the other remarks of that note are applicable to this method.

take the altitudes it has been customary to calculate them; there being given the latitude of the place, the apparent time, the right ascensions and the declinations of the objects. These calculations are long, when an altitude of a star is to be computed, and much more so when that of the moon is required, and a considerable degree of accuracy is required in finding from the Nautical Almanac, the moon's right ascension and declination, which must be liable to some error on account of the uncertainty of the ship's longitude. The following method of obtaining these altitudes is far more simple, and sufficiently accurate. This method depends on the supposition that the altitudes increase or decrease uniformly.

Before you measure the distance of the bodies, take their altitudes, and note the times by a watch, then measure the distance and note the time (or you may measure a number of distances, and note the corresponding times, and take the mean of all the times and distances for the time and distance respectively)—after you have measured the distances, again measure the altitudes, and note the times. Then from the two observed altitudes of either of the objects, the sought altitude of that object may be found in the following manner.

Add together the proportional logarithm (Table XXII.) of the variation of altitude* of the object between the two times of observing the altitudes, and the prop. log. of the time elapsed between taking the first altitude and measuring the distance, from the sum subtract the prop. log. of the time elapsed between observing the two altitudes of that object, the remainder will be the prop. log. of the correction to be applied to the first altitude, additive or subtractive according as the altitude was increasing or decreasing, to the altitude thus corrected, apply the correction for dip of the horizon and semi-diameter as usual.

EXAMPLE.

Suppose the distances and altitudes of the sun and moon were observed as in the following Table. It is required to find the altitudes at the time of measuring the mean distance?

Time.			Dist. ☉ and ☾		Observed. ☉'s L. L.	Time.			Observed. ☉'s L. L.	
2h.	2m.	20s.	40° 0'	0"		2h.	2m.	30s.	40° 20'	0"
	4	20		0 30	21	7	0		39	12
	5	30		1 30		4	30		1	2
Mean 2h.	4	30		40 0 40						

Var. ☉'s alt.	34'	P. L.	7238	Variation ☉'s alt.	1° 8'	P. L.	4523
Time el. obs. ☉	2h. 2' 0"			Time 1st. obs. sun	2h. 2' 30"		
Mean obs. of dist.	2 4 30			Time mean obs.	2 4 30		
Difference	2 30	P. L.	1.8573	Difference	2 0	P. L.	1.9542
			2.5811	Sum			2.5770
Elapsed time between the two observations	4' 10"	P. L.	1.8335	Elapsed time between the two observations	4' 30"	P. L.	1.6021
Correction of alt.	0° 20'	P. L.	9456	Correction of alt.	0° 30'	P. L.	7748
Alt. ☉'s L. L. at time of	21 6	add		Sub. from sun's 1st. alt.	40 20		
the mean obs.				Alt. ☉'s L. L. at time of the mean obs.	39 50		

Thus at the time 2h. 4' 30", the mean observed distance of the sun and moon's nearest limbs was 40° 0' 40", the altitude of the moon's lower limb 21° 6', and the altitude of the sun's lower limb 39° 50'; these altitudes must be corrected for dip and semi-diameter as usual.

* Table XXII is only calculated as far as 3°, and if the variation of altitude exceed that quantity, you must enter the table with minutes and seconds, instead of degrees and minutes, and the correction of minutes taken out in minutes and seconds must be called degrees and minutes respectively and add its arithmetical complement, neglecting 10 in the index of the sum.

In this manner I have often obtained the altitudes in much less time than they could have been obtained by other calculations.

The same method may be used for finding the sun's altitude, when taking an azimuth, by noting the times of taking the observations by a watch, and taking two altitudes the one before, the other after the observation, and proportioning the altitudes as above.

Any person who wishes to calculate strictly the apparent altitudes, may proceed according to the following rules.

The apparent time, the ship's latitude and longitude, and the sun's declination given, to find the apparent altitude of his centre.

RULE.

With the apparent time from noon, enter Table XXIII. and from the column rising take out the logarithm corresponding, to which add the log. co-sine of the latitude, and the log. co-sine of the sun's declination; their sum, rejecting 20 in the index, will be the logarithm of a natural number, which being subtracted from the natural co-sine of the sum of the declination and latitude, when they are of different names, or the natural co-sine of their difference when of the same name, will leave the natural sine of the sun's true altitude at the given time. The refraction less parallax being added to the true altitude, will give the apparent altitude.

In general it will be near enough to take out the refraction only from Table XII. and neglect the parallax.

EXAMPLES.

Required the true altitude of the sun's centre, in lat. $49^{\circ} 57' N.$ and long. $75^{\circ} W.$ July 26, 1820, at 6h. 56m. 30s. in the morning, sea account?

	H.	M.	S.	
App. time	12	0	0	
	6	56	30	
Time from noon	5	3	30	
Latitude	49	57	0N.	
Declin. at that time	19	26	0N.	
Difference	30	31		
True alt.			$23^{\circ} 45'$	
Refraction			2	
App. alt.			$23 \quad 47$	

its log. in col. of rising	. . . . .	4.53230
its log. co-sine	. . . . .	9.80202
its log. co-sine	. . . . .	9.97458
nat. number	. . . . .	45872 its log. = 4.65915
nat. co-sine	. . . . .	86148
nat. sine	. . . . .	40278

EXAMPLE II.

What will be the true altitude of the sun's centre in the latitude of $39^{\circ} 20' N.$ and the longitude of $40^{\circ} 50' W.$ November 26, 1820, at 3h. 21m. 30s. apparent time in the afternoon, sea account?

	H.	M.	S.	
App. time from noon	3	21	30	
Latitude	39	20	0N.	
Declin. at that time	20	52	0S.	
Sum	60	12		
True alt.			$13 \quad 36$	
Refraction			4	
App. alt.			$13 \quad 40$	

its log. in col. of rising	. . . . .	4.55000
log. co-sine	. . . . .	9.80202
log. co-sine	. . . . .	9.97000
nat. number	. . . . .	26181 its log. = 4.41700
nat. co-sine	. . . . .	49697
nat. sine	. . . . .	23516

The apparent time, the latitude and longitude given, to find the apparent altitude of a fixed star.

RULE.

Turn the longitude into time, and add it to, or subtract it from, the apparent time*

* The apparent time must be taken (as usual) one day less than the sea account, and the hours must be reckoned from noon to noon in numerical succession from 1 to 24. It may also be observed, that if the observer be furnished with a chronometer, regulated to mean Greenwich time, this part of the operation may be saved, reducing the mean time to apparent, by applying the equation Table IV. A, with a different sign from that in the Table, as is taught in the introduction to the tables.

at the ship, according as the longitude is west or east, the sum or difference will be the time at Greenwich.

Find, in the Nautical Almanac, the sun's right ascension for the noon preceding the time at Greenwich, and add thereto the correction taken from Table XXXI. corresponding to the hours and minutes of the time at Greenwich, the sum will be the sun's right ascension, which being added to the apparent time at the ship, will give the right ascension in *meridian*, rejecting 24 hours when the sum exceeds 24 hours.

Find the star's right ascension and declination in Table VIII. for the year 1820, and correct them for the years elapsed since that time, by means of the annual variations given in the same table, and you will obtain the star's right ascension and declination at the time of observation.*

The difference between the star's right ascension and the right ascension of the meridian, will be the distance of the star from the meridian.

Find, in the column of rising of Table XXIII. the logarithm corresponding to the star's distance from the meridian,† and add thereto the log. co-sine of the latitude of the ship, and the log. co-sine of the declination of the star, the sum, rejecting 20 in the index, will be the logarithm of a natural number (Table XXVI.) which subtracted from the natural co-sine (Table XXIV.) of the sum of the declination and latitude when of different names, or the natural co-sine of their difference when of the same name, will leave the natural sine of the star's true altitude.

The refraction being added to the true altitude will give the apparent altitude.

EXAMPLE.

What was the apparent altitude of Aldebaran, at Philadelphia, April 12, 1820, sea account, at 5h 57m 18s in the afternoon, apparent time?

In Table VIII. the right ascension of Aldebaran for 1820, is 4h. 25m 36s. and the variation for 34 months is 1' to be added because the time is after 1820; hence the right ascension at the given time 4h. 25m 37s. The declination of the star for 1820 is 16° 8' N its variation for 34 months being neglected.

	H.	M.	S.		
Apparent time by N. A. April 11,...	5	57	18		
Longitude 75° 9' W	5	0	36		
Time at Greenwich, April 11.....	10	57	54		
☉'s R. A. April 11, at noon, by N. A.	1	19	28		
Var. for 10h 57' 54" by Table XXXI.	1	41			
☉'s R. A. at time of obs.	1	21	9		
Apparent time	5	57	18		
R. A. Mer.	7	18	27		
★'s R. A.	4	25	37		
★'s dist from merid.	2	52	50	Its log. in col. rising.....	4.43318
Latitude of Philadelphia 39° 57' N.				co-sine.....	9.88457
★'s declination 16 8 N.				co-sine.....	9.98255
Difference 23 49	nat. number	19966	its log.		4.30030
	nat. co-sine	91484			
True altitude 45 39	nat. sine	71518			
Refraction 1					
Apparent altitude 45 40					

* If any of the 24 bright stars are used, whose right ascension or north polar distances are given for every 10 days in the year in the Nautical Almanac we can obtain from it by inspection the right ascension, and deduce the declination from the polar distance, and the numbers thus found having been corrected for aberration and nutation, are to be used as rather more accurate.

† If the distance from the meridian exceed 12 hours, you must subtract from 24 hours before entering Table XXIII.

To find the Longitude by the Eclipses of Jupiter's Satellites.

The eclipses of the satellites are given in page III. of the month of the Nautical Almanac for mean time at Greenwich. There are two kinds of these eclipses—an *Immersion*, denoting the instant of the disappearance of the satellite by entering into the shadow of Jupiter, and an *Emergence*, or the instant of the appearance of the satellite in coming from the shadow. The immersions and emergences generally happen when the satellite is at some distance from the body of Jupiter, except near the opposition of Jupiter to the sun, when the satellite approaches near to his body. Before the opposition they happen on the west side of Jupiter, and after the opposition on the east side, but if an astronomical telescope is used which reverses the objects, the appearance will be directly the contrary. The configurations, or the positions in which Jupiter's satellites appear at Greenwich, are laid down every night, when visible, in page XII. of the month of the Nautical Almanac.

As these eclipses happen almost daily, they afford the most ready means of determining the longitude of places on land, and might also be applied at sea, if the observations could be taken with sufficient accuracy in a ship under sail, which can hardly be done, since the least motion of a telescope which magnifies sufficiently to make these observations, would throw the objects out of the field of view.

As these eclipses are given in the Nautical Almanac in mean time, it is necessary to regulate your watch to mean time,* this is easily obtained from the apparent time by applying to the latter the equation of time taken from the Nautical Almanac, by adding or subtracting according to the directions in the column from whence the equation was taken, hence the error of a watch with respect to mean time may be ascertained.

The watch being thus regulated, you must then find nearly the time at which the eclipse will begin at the place of observation, this may be done as follows. Find from the Nautical Almanac the time of an immersion or emergence, and apply thereto the longitude turned into time, by adding when in east, but subtracting when in west longitude, the sum or difference will be nearly the mean time when the eclipse is to be observed at the given place. If there be any uncertainty in the longitude of the place of observation, you must begin to look out for the eclipse at an earlier period, and when the eclipse begins, you must note the time by the watch, and after applying the correction for the error of the watch, if there be any, you will have the mean time of the eclipse at the place of observation, the difference between this and the time in the Nautical Almanac, being turned into degrees, will be the longitude from Greenwich.

EXAMPLE.

Suppose that on the 21st of August, 1820, sea account, in the longitude of $127^{\circ} 55' W.$ by account, an immersion of the first Satellite of Jupiter was observed at 7h. 12m. 32s. P. M. mean time. Required the longitude?

By N. A. immersion	Aug. 20th.	15h. 47' 52"
By observ. Aug. 21, sea account, or by N. A.	Aug. 20th.	7 12 32

Longitude in time.....	8 35 20
------------------------	---------

which turned into degrees gives $128^{\circ} 50' W.$ for the longitude of the place of observation.

To find the Longitude by Eclipse of the Moon.

The determination of the longitude by an eclipse of the moon is performed by comparing the times of the beginning or ending of the eclipse, as also the times when any number of digits are eclipsed, or when the earth's shadow begins to touch or leave any remarkable spot on the moon's face, the difference of time between the like observations made at different places, turned into degrees, will be the difference of longitude of those places.

When the beginning or end of an eclipse of the moon is observed at any place, the longitude of that place may be easily found by comparing the time

* In the Almanac published before 1805, the apparent time of the eclipses was given instead of the mean time.

Having regulated a chronometer, in the manner first mentioned, at a place whose longitude from Greenwich is known, it is easy to find how much 't is too fast or too slow for the meridian of Greenwich, by allowing for the difference of meridians. Thus, if the above mentioned observation of June 1. was made in a place in 74° west longitude, corresponding in Table XXI. to 3h. 58m. the chronometer on that day would be too slow for Greenwich time by the sum of 4h. 58m. * and 2m. 20s. or 4h. 58m. 20s. In general it will be full as simple, when thus regulating a chronometer, at a place whose longitude is known, to reduce at once the mean time at the place of observation to the meridian of Greenwich, by adding the longitude if west, subtracting if east, the sum or difference will be the mean time of observation upon the meridian of Greenwich, the difference between this and the time given by the chronometer, shows how much it is too fast or too slow for Greenwich mean time. Thus by adding the longitude 4h. 58m. to the mean time of the above observation 5h. 32m. 10s. the sum 10h. 8m. 10s. is the mean time at Greenwich, from which subtracting the time by the chronometer 5h. 10m. 20s. the remainder 4h. 58m. 20s. is what the chronometer is too slow for Greenwich time, as was found before.

The chronometer having been thus regulated to Greenwich time, and the daily rate of its going ascertained, if this rate should remain unaltered, the time at Greenwich will be known by it, at any moment at sea, and if at that moment by any observation of the sun, moon, planet or a fixed star, the apparent time be found by any of the methods explained in pages 154—161, and the mean time at the ship deduced therefrom, by applying the equation of time, as above explained, then the difference between this mean time at the ship, and the mean time at Greenwich shown by the chronometer, will be the longitude, which may be turned into degrees and minutes by Table XXI. We shall explain by a few examples the preceding remarks.

EXAMPLE I.

Wishing to regulate a chronometer, in a place whose latitude is $51^{\circ} 30' N$ and longitude $114^{\circ} E$. from Greenwich, I observed Oct. 10, 1824, at 8h. 31m. A. M. sea account per chronometer, the altitude of the sun's lower limb by a fair observation $13^{\circ} 32'$, the correction for semi-diameter, parallax and dip being 12. It is required to find the error of the chronometer for mean time at Greenwich!

The apparent time of this observation, computed as in Example I. page 158. is 8h. 7m. 9s. A. M. corresponding to Oct. 9d. 20h. 7m. 9s. by the Nautical Almanac. From this subtract the longitude 114° turned into time 7h. 56m. by Table XXI. the remainder Oct. 9d. 12h. 31m. 9s. is the apparent time at Greenwich. Now by Table IV. A, the equation of time for Oct. 9d. at noon is sub. 12m. 44s. with a daily increase of 16s. and this in Table VI. A. under 16s. and opposite to 12h. 31m. 9s. gives 9s. to be added to 12m. 44s. (because it is increasing) the sum 12m. 53s. is the equation of time which by the table is subtractive from the apparent time at Greenwich Oct. 9d. 12h. 31m. 9s. to obtain the mean time at Greenwich Oct. 9d. 12h. 18m. 16s. If the mean time at the place of observation is required, it would be found by subtracting the equation of time 12m. 53s. from the apparent time at the place of observation, 8h. 7m. 9s. and it would therefore be 7h. 54m. 16s.

EXAMPLE II.

May 10, 1824, at 5h. 30m. P. M. sea account per chronometer, in latitude $39^{\circ} 54'$, in a place whose longitude was known to be $17^{\circ} 30' E$. from Greenwich, the altitude of the sun's lower limb by a fore observation was $15^{\circ} 45'$, the correction for dip, parallax and semi-diameter being 12. It is required to find the error of the chronometer for mean time at Greenwich, and at the place of observation?

* If the longitude had been east, it would have been subtractive. This is to be added if the ship's longitude is west.

184 TO FIND THE LONGITUDE BY A CHRONOMETER.

The apparent time of this observation, computed as in Example II. page 156, is May 9d. 5h. 34m. 26s. by the Nautical Almanac. From this subtract* the longitude 17° 30', turned into time, 1h. 10m. by Table XXI. the remainder May 9d. 4h. 24m. 26s. is the *apparent* time at Greenwich, By Table IV. A, the equation of time for May 9th. at noon is *sub.* 3m. 48s. with a daily increase of 3s. and this in Table VI. A, under 3s. and opposite 4h. 24m. 26s. is 1s. which added to 3m. 48s. (because it is increasing) gives the equation of time, at the moment of observation, *sub.* 3m. 49s. Subtracting this, according to the direction in the table, from the *apparent* time at Greenwich May 9d. 4h. 24m. 26s. leaves the *mean* time at Greenwich May 9d. 4h. 20m. 37s. Subtracting the same equation 3m. 49s. from the *apparent* time at the place of observation 5h. 34m. 26s. gives the *mean* time at the place of observation 5h. 30m. 37s. The difference between the *mean* time at Greenwich 4h. 20m. 37s. and the time by the chronometer 5h. 30m. is 1h. 9m. 23s. which is the time the chronometer is too fast for Greenwich *mean* time.

EXAMPLE III.

Suppose that July 27, 1820, sea account, the apparent time was found by an altitude of the sun to be 1h. 5' 8" P. M. when by a watch well regulated to mean Greenwich time, the time was 4h. 3' 8" P. M. Required the longitude?

Apparent time.....	1h. 5' 8"
Equation of time add	6 8
Mean time at place of observation	1 11 16
Time per watch.....	4 3 8
Difference in long.	2 51 52=42° 58' W. the longitude being west, because the time at Greenwich is the greatest.

EXAMPLE IV.

Suppose that May 14, 1820, sea account, the apparent time was found by an altitude of the sun to be 4h. 3' 5" P. M. when the time by the watch was 2h. P. M. the watch being too slow for mean Greenwich time 11' 9". Required the longitude?

Apparent time	4h. 3' 5"	Time per watch	2h. 0' 0"
Equation of time sub.....	3 56	Watch error add	11 9
Mean time at place of observ.	3 59 9 P. M.	Time at Greenwich	2 11 9 P. M.
Time at Greenwich	2 11 9		
Difference of longitude.....	1 48 0=27° 0' E.		

EXAMPLE V.

Suppose that on June 14, 1820, sea account, in a place whose longitude from Greenwich was known, a number of observations were taken to ascertain the going of the watch; and it was found that on that day it was 10' too slow for mean Greenwich time, and lost time 2" per day; and that on July 14, 1820, sea account, the time per watch was 6h. 0' 6" P. M. when, by an observed altitude of the sun, the apparent time was 1h. 16' 10" P. M. Required the longitude?

Apparent time	1h. 16' 10"	Error of watch, June 14,	0' 10" slow
Equation of time add	5 22	30 days at 2"	1 0 slow
Mean time at place of obser.	1 21 32	Error July 14,	1 10 slow
Time at Greenwich	6 1 16	Time per watch	6 0 6
Longitude	4 39 44=69° 56' W.	Time at Greenwich	6 1 16

* This is to be added if the ship's longitude is west.

TO REGULATE A CHRONOMETER.

185

To regulate a Chronometer by Lunar Observations.

It sometimes happens that a chronometer is by accident suffered to run down when at sea, in which case it can be regulated, by means of a great number of lunar observations, which must be taken with the greatest care, and with objects on different sides of the moon. These observations may be made on the same day, or on several successive days, finding by each observation how much the chronometer is too fast or too slow for Greenwich time, and taking the mean result for the error at the mean time of observation.

EXAMPLE I.			EXAMPLE II.			EXAMPLE III.		
1820.		m. s.	1819.		m. s.	1817.		m. s.
April 6.	Too fast 1st. obs.	2 12	April 20.	Too slow 1st. obs.	1 19	Aug. 5.	Too slow 1st. obs.	—0 24
" "	2d. obs.	2 08	" 21.	2d. obs.	1 21	" 6.	Too fast 2d. obs.	+0 15
" "	3d. obs.	2 06	" 22.	3d. obs.	1 28	" 8.	Too slow 3d. obs.	—0 7
" "	4th. obs.	2 10				" 9.	Too fast 4th. obs.	+0 4
		4) 36			3) 66			4) —0 12
Mean error		2 9	Chro. too slow April 21,		1 22	Chro. too slow, Aug. 7		—0 3

In the last example some of the observations made the chronometer too slow, and others too fast; these are marked with different signs + and —, the sum is to be found, noticing the signs in the algebraical manner, as taught in the introduction to the appendix of this work.

It has lately been discovered that chronometers generally go faster on board of a vessel than when on shore; this variation has been sometimes found to be as much as 14 seconds per day, though in general not more than 1 or 2 seconds. It is suspected that this arises from the attraction of the iron in the vessels, the chronometer having acquired a small degree of magnetism. To remedy this inconvenience it has been recommended to keep the chronometers always in the same place on board the ship, and to regulate them when thus placed, before leaving the port, or by means of lunar observations (after the above manner) when at sea. Thus, in the first of the above examples, the chronometer was 2m. 9s. too fast for Greenwich time April 9, 1820, suppose now by a set of lunar observations made April 30, 1820, it was found to be fast 2m. 30s. the variation would be 21s. in 21 days, which is 1 second per day for the acceleration of the chronometer.

It has also been found that chronometers generally gain by an increase of density of the air, and lose by a decrease of density. The firing of guns on board a vessel will sometimes alter the rate of going, unless the instrument be well suspended, or held in the hand during the firing. Any sudden jar will sometimes alter the rate. The imperfection of the oil used will after sometime impair the instrument. Finally, the mechanism used to correct the change of temperature of the air may not do it completely, and some error may arise from this source. Notwithstanding these various causes of error, it is wonderful to observe how accurately some of those chronometers perform their office.

To find the Longitude by a Variation Chart.

In the year 1700, Dr. Halley proposed to find the longitude by a chart to be published, on which the lines of the variation of the compass were drawn; and since that time several similar charts have been published for the same purpose; but the difficulty of determining the variation, combined with other causes, will probably prevent this method from being sufficiently accurate to be generally useful.

The method of using this chart is as follows: On the parallel of latitude which you are in, find the observed variation, and that point will be the Place of observation.

A chart, on which the lines of the dip of the magnetic needle are marked, might be used in the same manner for determining the longitude.

BY LOGARITHMS.

Between the S. S. W. line AB and the S. E. by E. line AC, are 7 points, $\angle BAC$; and between the S. E. by E. line AC, and the E. by S. line AD are 2 points $\angle CAD = \angle ACB$ (because AD, BC are parallel)—therefore $\angle ACB + \angle BAC = 9$ points, and since all three angles $\angle ACB$, $\angle BAC$, $\angle ABC$ are equal to 16 points, the angle $\angle ABC$ is also equal to 7 points, therefore (*by art. 39 Geom.*) the sides AC, CB are equal, being opposite to the equal angles $\angle ABC$, $\angle BAC$. If these angles had not been equal, the side AC might have been calculated in the same manner as we shall now calculate the side AB.

To find the side AB.	
As sine BAC 7 points co. ar.	0.00843
Is to BC 15 miles	1.17609
So is sine ACB 2 points	9.58284
<hr/>	
To AB 5.85	0.76736

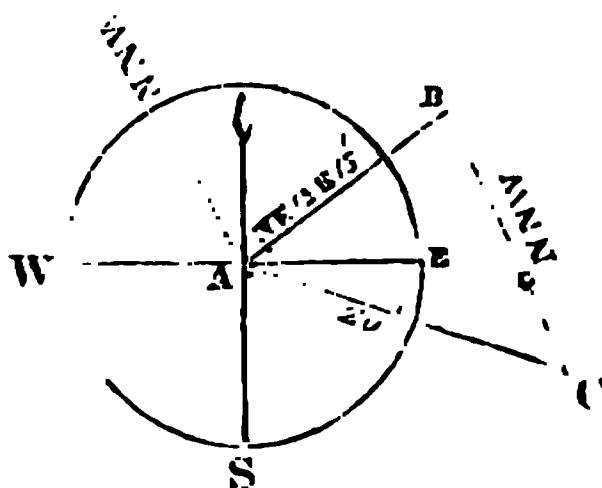
This Problem or the first may be used for finding the distance of a ship from any head-land, &c. when taking her departure from the land.

PROBLEM III.

Two ships sail from the same port, one sails N. E. $\frac{1}{2}$ E. 16 miles, the other sails easterly 20 miles, and then finds that the first bears N. N. W. Required the other ship's course, and the distance between the two ships?

BY PROJECTION.

Draw the compass ESW, and let its centre A represent the port sailed from; draw the N. E. $\frac{1}{2}$ E. line AB = 16 miles, and through B. the line BC. parallel to the N. N. W. line, and continue it indefinitely; take 20 miles in your compasses, and putting one foot in A. describe with the other an arch cutting the line BC in C. and join AC. Then B will be the place of the first ship, C that of the second, and AC the course steered by the second ship, which will be nearly E. S. E. $\frac{1}{2}$ E. and BC the distance of the ships 17 $\frac{1}{2}$ miles.



BY LOGARITHMS.

The course from B to C is S. S. E. (opposite to N. N. W.) and from B to A is S. W. $\frac{1}{2}$ W. (opposite to N. E. $\frac{1}{2}$ E.) the difference between these bearings is 6 $\frac{1}{2}$ points = $73^{\circ} 7'$ = the angle $\angle ABC$; having this angle and the sides AB, AC, the other angles and side may be found by Cases II. and III. of Oblique Trigonometry as follows:

To find the angle C.

As the side AC 20 miles
sine ABC $73^{\circ} 7'$
Is to side AB 16 miles

Subtract

sine angle C $49^{\circ} 57'$
N. N. W. add $22^{\circ} 30'$

makes N. $72^{\circ} 27'$ W. the bearing of A
from C, whence the course of the ship from A
towards C, is S. $72^{\circ} 27'$ E. or E. S. E. $\frac{1}{2}$ E.

To find the distance of the ships BC.

1.50103
9.92087
1.20412
And the angle C = $49^{\circ} 57'$ to the angle B $73^{\circ} 7'$,
the sum $123^{\circ} 4'$ being subtracted from 180° leaves
the angle CAB $56^{\circ} 56'$.

11.18474
1.30103
3.88371
As sine ang. ABC $73^{\circ} 7'$ ar. co.
Is to the side AC 20 miles
So is sine CAB $56^{\circ} 56'$

To the side BC 17.5 miles

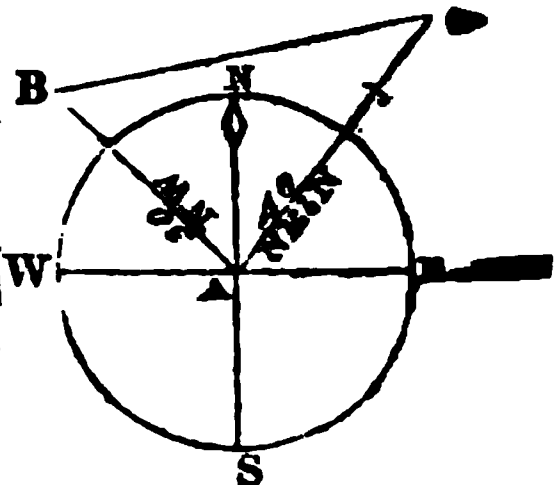
0.01913
1.50103
9.92087
1.21542

PROBLEM IV.

Two ships sail from the same port, one N. W. 30 miles, and the other N. E. by N. 40 miles. Required the bearing and distance of the ships from each other

BY PROJECTION.

Draw the compass NESW, and let its centre A represent the port sailed from; draw the N. W. line AB=30 miles, and the N. E. by N. line AC=40 miles, join BC, which will be the bearing and distance of the two ships. Whence the bearing will be found to be W. S. W. $\frac{1}{2}$ W. and the distance 45.1 miles nearly.



BY LOGARITHMS (by Cases IV. and V. Ob. Trig.)

Between the N. W. line AB and the N. E. by N. line AC, there are points=angle BAC, half the supplement of which to 180° is $50^\circ 37\frac{1}{2}'$ =half sum of the angles C and B.

To find the angles.			To find the distance BC.		
As sum of AB and AC 70	log. ar. co.	8.15490	As sine angle B $60^\circ 30'$	ar. co.	0.6603
Is to their difference 10		1.00000	Is to side AC 40		1.0090
So is tang. $\frac{1}{2}$ sum angles $50^\circ 37\frac{1}{2}'$		10.08583	So is sine angle A $78^\circ 45'$		9.9915
<hr/>			<hr/>		
To tan. $\frac{1}{2}$ diff.	9 $52\frac{1}{2}$	9.24073	To the distance BC 45.1		1.6539
<hr/>			<hr/>		
Sum=angle B	60	30			
Diff.=angle C	40	45			

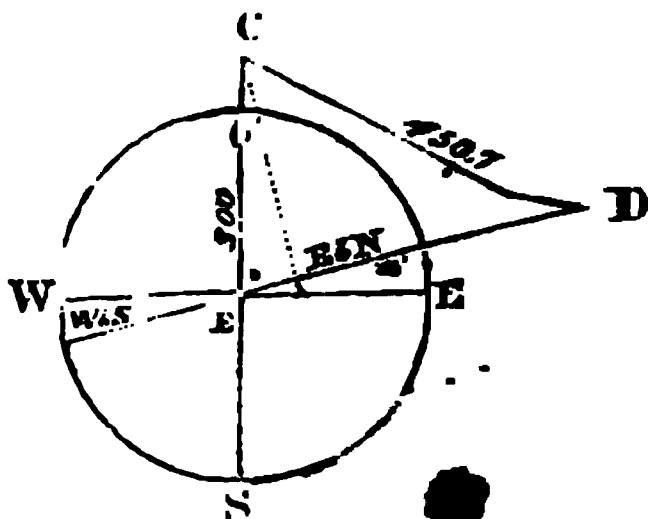
To the angle C= $40^\circ 45'$, add the course from C to A= $35^\circ 45'$, the sum is $74^\circ 30'$, which is the bearing of B from C, viz. S. $74^\circ 30'$ W. or W. S. W. $\frac{1}{2}$ W. nearly.

PROBLEM V.

Two ports bear from each other E. by N. and W. by S. distance 400 miles; a ship from the easternmost sails northerly 450.7 miles, another from the westernmost sails 300 miles, and meets the first. Required the course steered by each ship?

BY PROJECTION.

Draw the compass ESW, and let the centre B represent the westernmost port; draw the E. by N. line BD=400 miles, and D will be the easternmost port; with 300 in your compasses and one foot in B, describe an arch; with 450.7 in your compasses, and one foot in D, describe another arch cutting the former in C; join DC, BC. Then BC will be the course sailed by the westernmost ship, and DC the course sailed by the easternmost.



BY LOGARITHMS.

To find the angle CBD.

By Theo. IV. Trig.

Triangle BCD into two right-angled triangles of the perpendicular CA, and then

400 ar. co.	7.59794
BC, CD,	750.7 2.87547
C, CD,	150.7 2.17811
	282.2 2.45152
	141.4
	200

58.6

in the triangle ACB.

100	2.47712
	10.00000
	1.76750

78° 44'	9.25978
---------	---------

By Theo. V. Trig.

CD=450.7

BD=400

BC=300

log. ar. co.	7.38794
log. ar. co.	7.52228

Sum	1150.7
1/2 sum	575.35
1/2 sum less CD	124.65

log.	2.75998
log.	2.09569

Half sum 39° 22'

sum	19.77844
co-sine	9.88823

Doubled is 78° 44' = Angle CBD. Having found this angle, we may find either of the others thus, To find the angle CDB.

As CD 450.7 ar. co.	7.34611
Is to sine CBD 78° 44'	9.90155
So is BC 300	2.47712

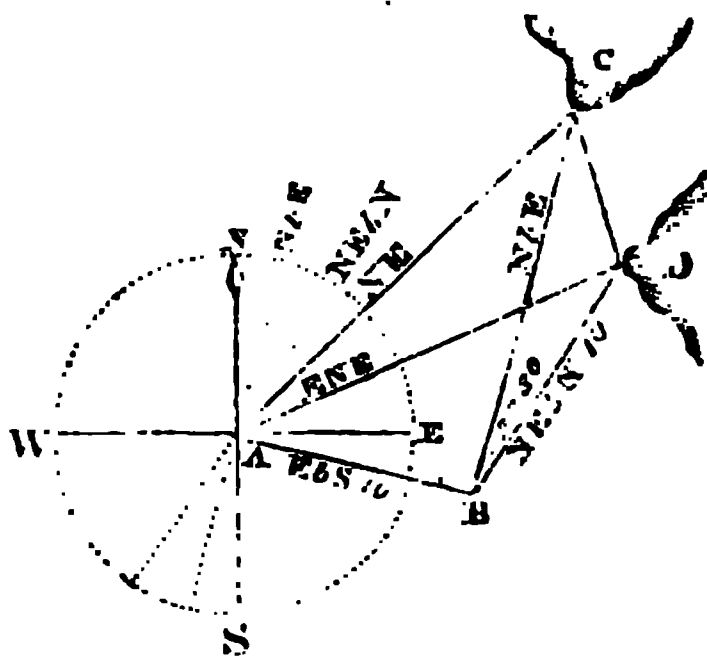
To sine CDB 40° 45'	9.81478
---------------------	---------

Angle CBD is 78° 44' or 7 points nearly, and the course from B to D the course from B to C must be north. The course from D to by S. or W. 11° 15' S. and the angle BDC=40° 45' the bearing D must be W. 29° 30' N. because 40° 45'—11° 15'=29° 30'.

PROBLEM VI.

along shore, I saw two headlands, the first bore from me N. E. the 1. E.—after sailing E. by S. 10 miles, the first bore N. by E. and N. E. by N. Required the bearing of the two headlands from each their distance?

compass NESW, and let represent the place of the first station; draw the E. AB=10 miles, and B will be the ship at the second station the N. E. line AC, and the line AD; through the point B lines BC, BD parallel to the line N. E. by N. lines, and C and D where they intersect lines drawn from A to the headlands will be the points respectively; join the line CD;—then will CD be the



the two headlands, and a line drawn through A parallel to CD will give the bearing of those places from each other on the compass.

BY LOGARITHMS.

In the triangle ABC, we have all the angles and find BC. For the bearings of B are E. by S. and N. E. the difference=BAC; and the bearings of B are S. by W. and S. W. the difference equal to the angle ACB.

To find the side BC.

3 pts. ar. co.	0.25526
B 10	1.00000
BAC 5 pts.	9.91815
	1.17511

In the triangle ABD, we have all the angles and the side AB to find BD. For the bearings of B and A from D, are S. W. by S. and W. S. W. the difference being 5 points=BDA; and the bearings of B and D from A, are E. by S. and E. N. E. the difference being also 5 points, equal to the angle BAD; therefore the angle BAD=BDA, and (by art. 39 Geom.) BD=AB=10 miles. If these angles had not been equal, we might have calculated the side BD in the same manner as BC.

In the triangle CBD we have BD=10, BC=14.97, and the angle 30', for the bearings of C and D from B are N. by E. and N. E. bearing 2 points or 22° 30'; hence we may find the other angles and in case IV. Obl. Trig.

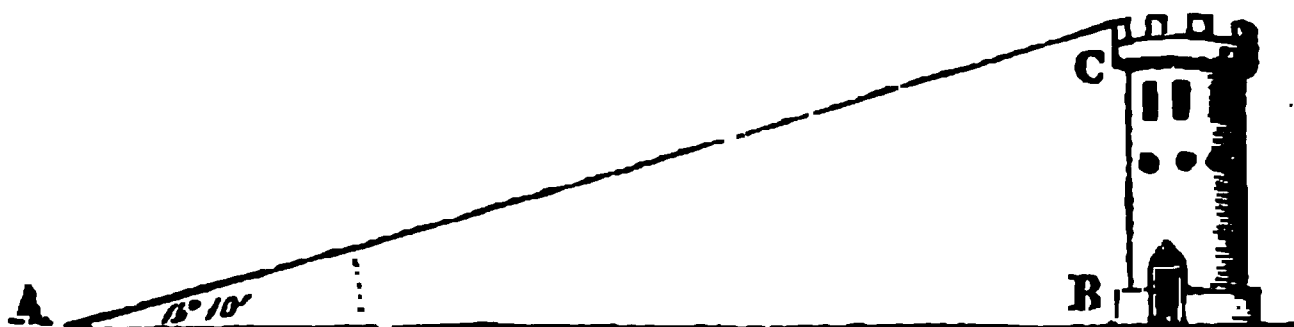
To find the angles BCD, BDC.
 As sum of BC, BD 24.97 ar. co. . . . 8.60238
 Is to their diff. 4.97 0.69686
 So is tan. ha. sum. op. ang. $73^{\circ} 45'$. . . 10.70134
 To tang. $\frac{1}{2}$ diff. . . . 45 1 . . . 10.00028
 Sum is angle BDC = $123^{\circ} 46'$
 Diff. is angle BCD = $53^{\circ} 44'$ or nearly 3
 points, and as the bearing of B from C is S. by W.
 the bearing of D from C must be S. S. E.

To find the distance CD.

As sine ang. BCD $33^{\circ} 44'$ ar. co. . . . 0.235
 Is to side BD 10 1.00000
 So is sine angle CBD $22^{\circ} 30'$ 0.385
 To the distance CD 6.89 0.835

PROBLEM VII.

Being 96 fathoms from the bottom of a tower, I found its altitude above the horizontal line drawn from my eye was $15^{\circ} 10'$. Required the elevation above that line?



BY PROJECTION.

Draw the horizontal line AB = 96 fathoms, and perpendicular thereto, the line BC: make the angle BAC = $15^{\circ} 10'$ and draw AC to cut BC in C, then will BC be the height of the tower 26 fathoms.

BY LOGARITHMS.

As radius 90° 10.00000
 Is to the dist. AB 96 fathoms 1.98227
 So is tang. angle A $15^{\circ} 10'$ 9.43308
 To the height BC 26.0 fathoms . . . 1.41535

When an object, whose elevation above the horizon is to be determined, is at a very great distance, it will be necessary to notice the correction arising from the curvature of the earth and the refraction, and apply that correction to the height estimated by the above method. Thus if the angular elevation of a mountain whose base was more distant than the limit of the visible horizon, was observed by an instrument of reflection; the approximate height must first be obtained, as in the preceding example, and then the correction of that approximate height for the curvature of the earth, refraction, and dip, must be calculated by the following rule, and added to that height, the sum will be the true height above the level of the sea.

RULE. Find in Table X. the number of miles corresponding to the height of the observer above the level of the sea, and take the difference between that number and the distance of the mountain from the observer in statute miles; with that difference enter the same table and find the height in feet corresponding, which will be the correction to be added to the approximate height to obtain the true height of the mountain above the level of the sea.

EXAMPLE. Suppose the distance was 32 statute miles (or 168960 feet) and the observed altitude $1^{\circ} 2'$, the observer being 18 feet above the level of the sea. Required the height of the mountain above the same level?

As radius 10.00000
 Is to distance 168960 log. . . . 5.22779
 So is elevation $1^{\circ} 2'$ tang. . . . 8.25616

Approx. height 2048 log. . . . 3.42335
 Correction 398

Sum 2446 is the true height above the level of the sea.

Dist. of mountain M. 32
 Tab. X. 18 feet 561

Difference 26.39
 Corresponding Corr. Tab. X. . . . 398 ft.

PROBLEM VIII.

While sailing towards Cape-Cod, I discovered the light-house just appearing in the horizon, my eye being elevated 20 feet above the sea ; it is required to find the distance of the light-house, supposing it to be elevated 200 feet above the surface of the sea ?

The solution of this problem depends on the uniform curvature of the sea, by means of which all terrestrial objects disappear at certain distances from the observer. These distances may be computed by means of Table X. in

which the elevation in feet is given in one column, and the distance at which the object is visible, is expressed in statute miles in the other column. If the place at which you view the object be elevated above the horizon, you must add together the distances corresponding to the height of the observer and the height of the object, the sum will be the greatest distance at which that object can be seen from the observer.

In the present example the height of the observer was 20 feet, and the height of the object 200 feet.

Table X. opposite 20 feet is 5.92 miles.
 opposite 200 feet 18.71

Distance 24.63 statute miles of about 69½ to a degree, being about 7.

PROBLEM IX.

A man being on the main-top-gallant-mast of a man of war, 200 feet above the water, sees a 100 gun ship she had engaged the day before, hull to ; how far from each other are these ships distant from each other ?

The height of a ship of 100 guns or a first rate man of war, is about 60 feet from the water to the rails, from which deduct about 20, leaves 40 for the height of her upper-deck above water. Now a ship is seen hull to when her upper-deck just appears.

In Table X. opposite 200 feet stand 18.71
 opposite 40 feet 3.37

Distance 22.08 miles.

PROBLEM X.

On seeing the flash of a gun, I counted 30 seconds by a watch before I heard the report : How far was that gun from me, supposing that sound moves at the rate of 1142 feet per second ?

The velocity of light is so great, that the seeing of any act done even at a great distance, is instantaneous ; but by observation it is found that sound moves at the rate of 1142 feet per second, or about one statute mile in 4.6 seconds ; consequently the number of seconds elapsed between the flash and hearing the report, being divided by 4.6 will give the distance in statute miles. In the present example the distance was about 6½ because 30 divided by 4.6 quotes 6½ nearly.

PROBLEM XI.

To find the difference between the true and apparent directions of the wind.

Suppose that a ship moves in the direction CB from C while the wind moves in its true direction from A to B. The effect on the ship will be the same as if she was at rest and the wind blew in the direction AC with a velocity represented by AC, the velocity of the ship being represented by BC.

In this case the angle BAC will represent the difference between the true and apparent directions of the wind : the apparent being more a-head than the true, and the farther the vessel goes the more a-head the wind will appear to be. We must, however, except the case where the wind is directly aft, in which case the direction is not altered. This is owing to the difference between the true and appa-



rent directions of the wind, that it appears to shift its direction by tacking ship; and if the difference of the directions be observed when on different boards (the wind on both tacks being supposed to remain constant, and the vessel to have the same velocity and to sail at the same distance from the wind) the half difference will be equal to the angle BAC: by knowing which, together with the velocity of the ship BC, and the angle BCA, we may obtain the true velocity of the wind; or, by knowing the velocity of the wind and of the ship, and the apparent direction of the wind, we may calculate the difference between the true and apparent directions of the wind.

Thus if the velocity of a ship represented by BC be 7 miles per hour, that of the wind represented by AB 27 miles per hour, and the angle of the vessel's course with the apparent direction of the wind $BCA = 7\frac{1}{2}$ points, the difference between the true and apparent directions of the wind would be obtained by drawing the line $BC = 7$ miles taken from any scale of equal parts and making the angle $BCA = 7\frac{1}{2}$ points, then with an extent equal to 27 miles, taken from the scale, and with one foot in B describe an arch to cut the line AC in A, join AB: then the angle BAC being measured, will be the sought difference between the true and apparent directions of the wind.

BY LOGARITHMS.

As AB	27 miles	log. ar. co.	3.56364
Is to BCA	$7\frac{1}{2}$ points	log. sine	9.99790
So is BC	7 miles	log.	0.84510
<hr/>			
To BAC	$11^{\circ} 57'$	log. sine	9.41164

So that in this case the difference between the true and apparent direction of the wind is about $1\frac{1}{2}$ points, and by tacking ship and sailing on the other board as above mentioned, the wind would appear to change its direction above $2\frac{1}{2}$ points.

PROBLEM XII.

To measure the height of a mountain by means of the heights of two barometers taken at the top and bottom of the mountain.

Procure two barometers with a thermometer attached to each of them in order to ascertain the temperature of the mercury in the barometers, and two other thermometers of the same kind to ascertain the temperature of the air. Then one observer at the top of the mountain, and another at the bottom, must observe at the same time the heights of the barometers and the thermometers attached thereto, and the heights of the detached thermometers, placed in the open air, but sheltered from the sun. Having taken these observations, the height of the upper observer above the lower may be determined by the following rule, which is adapted to a scale of English inches and to Fahrenheit's thermometer.

RULE. Take the difference of the logarithms of the observed heights of the barometer at the two stations, considering the first four figures, exclusive of the index, as whole numbers, the remainder as decimals; to this difference must be applied the product of the decimal 0.454, by the difference of the altitudes of the two attached thermometers, by subtracting if the thermometer was highest at the lowest station, otherwise adding: the sum or difference will be the approximate height in English fathoms. Multiply this by the decimal 0.00244, and by the difference between the mean of the altitudes of the detached thermometers and 32° , the product will be a correction to be added to the approximate height when the mean altitude of the two detached thermometers exceeds 32° , otherwise subtracted; the sum or difference will be the true height of the upper above the lower observer in English fathoms, which multiplied by 6 will be the height in feet.

EXAMPLE.

Suppose the following observations were taken at the top and bottom of a mountain. Required its height in fathoms?

	Attached therm.	Detached therm.	Barometer.	
Obs. at lower station	57°	56°	29,68 inch.	log. 14724,6
Upper station	43	42	25,28	log. 14027,8
Difference	14	Mean 49	Difference	696,8
		32	$0,454 \times 14$	6,4
		Diff. 17	Approx. height	690,4
			$690,4 \times 17 \times 0,00244$	28,6
			Height in fath.	719,0



MENSURATION.

PROBLEM I.

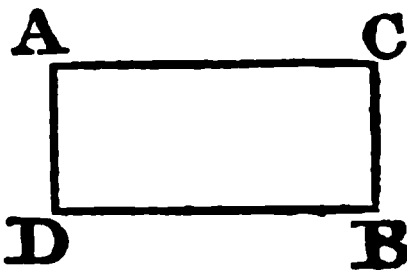
To find the area of a Parallelogram.

RULE.

MULTIPLY the base by the perpendicular height, the product will be the area.

NOTE. If both dimensions are given in feet, inches, &c. the product will be the area expressed in square feet, square inches, &c. respectively; if one of the dimensions be given in feet and the other in inches, the product divided by 12 will be the answer in square feet; if both dimensions are given in inches, the product will be square inches, which divided by 144 will be the answer in square feet. The same is to be understood in finding the area of other surfaces.

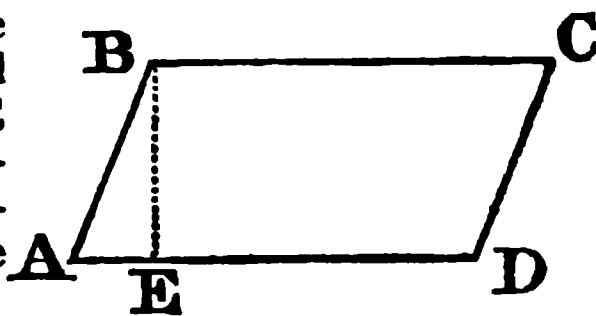
EXAMPLE I. Suppose the base DB of the rectangular parallelogram ACBD is 7 feet, and the perpendicular BC 3 feet; required the area? The product of the base 7 feet by the perpendicular 3 feet gives the area 21 square feet.



EXAMPLE II. Suppose ACBD is a board whose length DB is 22 feet and breadth BC is 14 inches; required the number of square feet? The product of the base 22 feet by the breadth 14 inches is 308, this divided by 12 gives 25 square feet, the sought area.

EXAMPLE III. If DB be 25 inches and BC 20 inches; required the area in square feet? The product of the base 25 inches by the perpendicular 20 inches gives 500, which divided by 144 gives the area 3,47 or $3\frac{47}{100}$ square feet.

EXAMPLE IV. Given the base AD of the oblique angular parallelogram ABCD, equal to 30 feet, and the perpendicular height BE 15 feet; required the area of the parallelogram? Multiply the base 30 feet by the perpendicular 15 feet; the product 450 is the area in square feet.



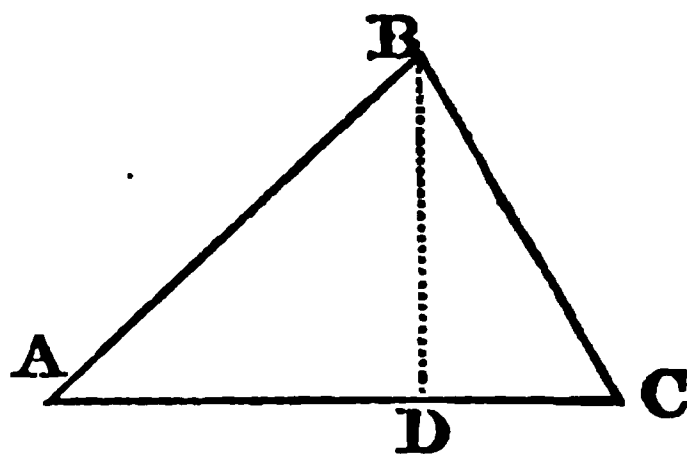
PROBLEM II.

To find the area of a Triangle.

RULE. Multiply the base by half the perpendicular height, and the product will be the area required.

C c

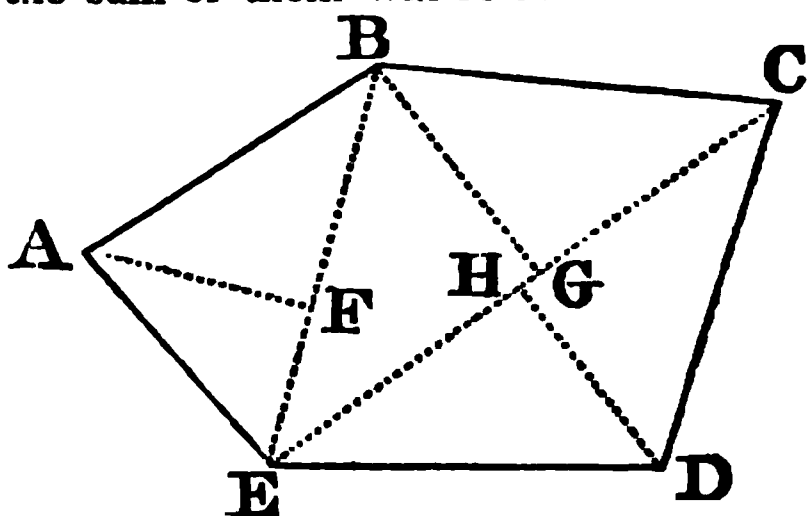
EXAMPLE. Given the base AC 30 feet, and the perpendicular DB 20 feet, required the area of the triangle? The base 30 multiplied by half the perpendicular 10 gives the area 300 square feet.



PROBLEM III.

To find the area of any irregular right-lined figure.

RULE. Reduce the figure to triangles by drawing diagonals therein; then find the area of each triangle, and the sum of them will be the area of the proposed figure. Or, instead of finding the area of each triangle separately, you may find at one operation the area of two triangles having the same diagonal by multiplying the diagonal by half the sum of the perpendiculars let fall thereon.



EXAMPLE. Required the area of the figure ABCDE, in which $EC=33$ feet, $EB=22$ feet, and the perpendicular $AF=13$ feet, $BG=14$ feet, and $DH=12$ feet? The diagonal EB, 22 feet, multiplied by half the perpendicular AF, 6.5 feet, gives the area of the triangle AEB, 143 square feet; and the diagonal EC, 33 feet, multiplied by half the sum of the perpendiculars BG DH, 13 feet, gives the area of the figure BCDE, 429 feet; this added to the triangle AEB 143 feet gives the whole area 572 square feet.

PROBLEM IV.

To find the area of a circle.

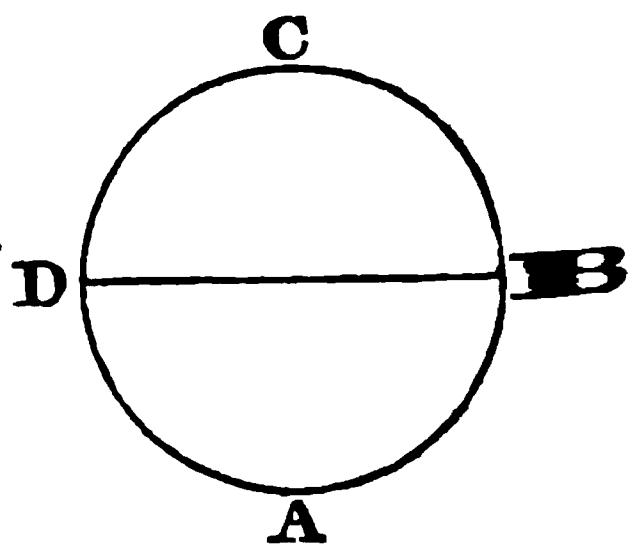
RULE. Multiply the square of the diameter of the circle by the quantity 0.7854, and you will have the sought area.

NOTE. Instead of multiplying by 0.7854 you may multiply by 11 and divide by 14, the quotient will be the area nearly. This quantity .7854 represents the area of a circle whose diameter is 1. The circumference of the same circle being 3.1416 nearly. The proportion of the diameter to the circumference is expressed in whole numbers by the ratio of 7 to 22 nearly; or more exactly by 113 to 355.*

EXAMPLE.

Required the area of a circle ABCD, whose diameter BD is 10.6 feet?

The diameter 10.6 multiplied by itself and by .7854 gives the sought area 88.247544 square feet.



PROBLEM V.

To find the area of an Ellipsis or Oval.

RULE. Multiply the longest diameter by the least, and the product by

* This ratio may be easily remembered by observing that if the first three odd numbers 1, 3, 5, are repeated twice, they will produce the quantity 113355; the three first figures of which make the first term of the ratio, and the three last the last term of the ratio.

.7854, this last product will be the area required.

EXAMPLE. Required the area of an Ellipsis or Oval ABCD, whose longest diameter AC is 12 feet, and the shortest diameter BD 10 feet?

The product of the two diameters is $12 \times 10 = 120$, this multiplied by .7854 gives the sought area 94.2480 square feet.

The area of a sector of a circle may be found by means of the whole area of the circle obtained in Problem IV. by saying, as 360 degrees is to the angle contained between the two legs of the sector, so is the whole area of the circle to the area of the sector.

There are various regular solids, the most noted are the following.—(1) A *Cube*, which is a figure bounded by six equal squares. (2) A *Parallelepiped* which is a solid terminated by six quadrilateral figures, of which the opposite ones are equal and parallel. (3) A *Cylinder*, which is a figure formed by the revolution of a rectangular parallelogram about one of its sides. (4) A *Pyramid*, which is a solid decreasing gradually from the base till it comes to a point. There are various kinds of Pyramids according to the figure of their bases: thus if the base be a triangle, the solid is called a *triangular pyramid*; if a parallelogram, a *parallelogramic pyramid*; and if a circle, a *circular pyramid*, or simply a *Cone*. The point in which the pyramid ends, is called the *Vertex*, and a line drawn from the vertex perpendicular to the base is called the height of the pyramid.

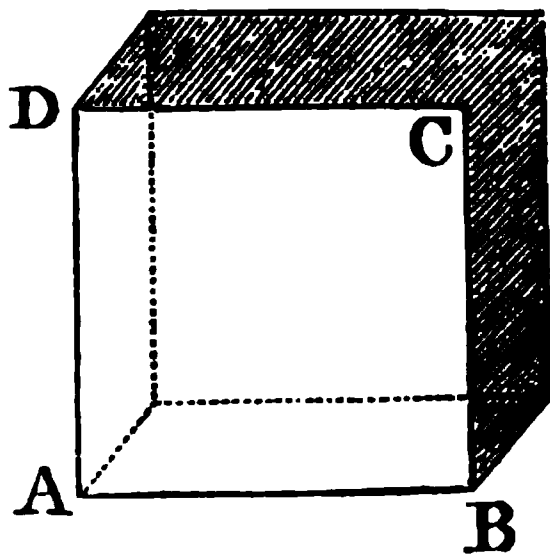
PROBLEM VI.

To find the solidity of a Cube.

RULE. Multiply the length of a side of the Cube by that length, and that product by the same length, and you will have the solidity required; which will be expressed in cubic feet if the dimensions were given in feet; but in cubic inches if the dimensions were given in inches, &c.

EXAMPLE. If the side AB of the cube of 6.3 feet it is required to determine the solidity?

The product of 6.3 by 6.3 is 39.69, this multiplied again by 6.3 gives the solidity 250.047 cubic feet.



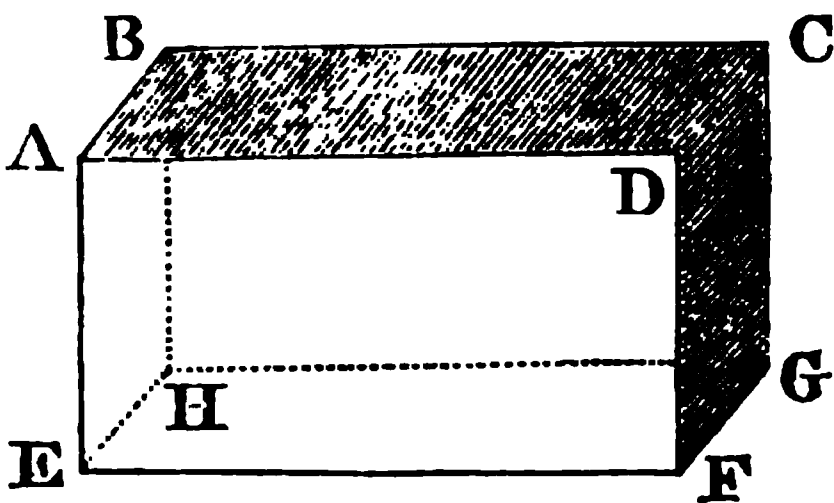
PROBLEM VII.

To find the solidity of a Rectangular Parallelepiped.

RULE. Multiply the length, breadth and depth, into each other; the product will be the solidity required.

EXAMPLE. Suppose in the parallelepiped ABCDFGHE, the length EF is 36 feet, the breadth GF 16 feet, and the depth FD 12 feet; it is required to find the solidity?

The product of the length 36 by the breadth 16 is 576, this multiplied by the depth 12 gives the solidity 6912 cubic feet.



PROBLEM VIII.

To find the solidity of a Cylinder.

RULE. Multiply the square of the diameter of the base by the length and this product by the constant quantity .7854; this last product will be the solidity required.

If the vessel be double-decked, take the length thereof from the fore part of the main stem to the after part of the stern-post above the upper deck ; the breadth thereof at the broadest part above the main wales, half of which breadth shall be accounted the depth of such vessel ; then deduct from the length three-fifths of the breadth, multiply the remainder by the breadth, and the product by the depth ; divide this last product by ninety-five, and the quotient will be the true content or tonnage of such vessel.

If the vessel be single-decked, take the length and breadth as above directed, in respect to a double-decked vessel, and deduct from the length three-fifths of the breadth, and taking the depth from the under side of the deck plank to the ceiling of the hold ; multiply and divide as aforesaid, the quotient will be the true content or tonnage of such vessel.

EXAMPLE. Suppose the length of a double-decked vessel is 80 feet, and the breadth 24 feet. what is her tonnage ? Three-fifths of the breadth 24 feet, is 14.4 feet, which, subtracted from the length 80 feet, leaves 65.6. This multiplied by the breadth 24 feet gives 1574.4, this multiplied by the depth 12 feet (half of 24) gives 18892.8, which divided by 95 quotes the tonnage 198.3.

Carpenters, in finding the tonnage, multiply the length of the keel by the breadth of the main beam and the depth of the hold in feet, and divide the product by 95 ; the quotient is the number of tons. In double-decked vessels half the breadth is taken for the depth.



GAUGING.

HAVING found the number of cubic inches in any body by the preceding rules, you may thence determine the content in gallons, bushels, &c. by dividing that number of cubic inches by the number of cubic inches in a gallon, bushel, &c. respectively.

A *wine gallon*, by which most liquors are measured, contains 231 cubic inches. A *beer gallon*, by which beer, ale, and a few other liquors are measured, contains 282 cubic inches. A *bushel* of corn, malt, &c. contains 2150.4 cubic inches : this measure is subdivided into 8 gallons, each of which contains 268.8 cubic inches.

In all the following rules, it will be supposed that the dimensions of the body are given in inches, and decimal parts of an inch.

PROBLEM I.

To find the number of gallons or bushels in a body of a cubic form.

RULE. Divide the cube of the sides by 231, the quotient will be the answer in wine gallons ; or by 282 and the quotient will be the answer in beer gallons ; or by 2150.4, and the quotient will be the number of bushels.

EXAMPLE. Required the number of wine gallons contained in a cubic cistern, the length of whose side is 62 inches. Multiplying 62 by itself and the product again by 62, gives the solidity 238328 ; which divided by 231 gives the content 1031½ wine gallons.

PROBLEM II.

To find the number of gallons or bushels contained in a body of the form of a rectangular Parallelepiped. See the figure of Problem VII. of Mensuration.

RULE. Multiply the length, breadth, and depth together ; divide this last product by 231, for wine gallons ; by 282 for beer gallons ; and by 2150.4 for bushels.

EXAMPLE. Required the number of wine gallons contained in a cistern ABCDFGHE (see fig. Prob. VII. of Mensuration) of the form of a parallelepiped, whose length EF is 66 inches, its breadth GF 35 inches, and its depth FD 24 inches. Multiplying the length 66 by the breadth 35 gives 2310, this multiplied by the depth 24, gives the solidity 55440 ; which divided by 231 quotes 240 wine gallons.

PROBLEM III.

To find the number of gallons or bushels contained in a body of a cylindrical form.

RULE. Multiply the square of the diameter by the height of the cylinder, and divide the product by 294.12, the quotient will be the number of wine gallons ; if you divide by 359.05 the quotient will be the number of ale gallons ; and if you divide by 2738, the quotient will be the number of bushels.

NOTE. These divisors are found by dividing 231, 282, and 2150.4 by .7854.

EXAMPLE. Required the number of wine gallons contained in the cylinder AFHD (See the fig. of Prob. VIII. of Mensuration) the diameter AD of its base being 26 inches, and length HD 18 inches ? The diameter 26 multiplied by itself gives 676, this multiplied by the length 18, gives the solidity 12168, which divided by 294.12, gives the answer 41 wine gallons.

PROBLEM IV.

To find the number of gallons or bushels contained in a body of the form of a pyramid or cone. (See figures of Problem X. of Mensuration.)

RULE. Multiply the area of the base of the pyramid or cone by one-third of its perpendicular height ; the product divided by 231 will give the answer in wine gallons ; if divided by 282, the quotient will be the number of beer gallons ; and if divided by 2150.4, the quotient will be the number of bushels.

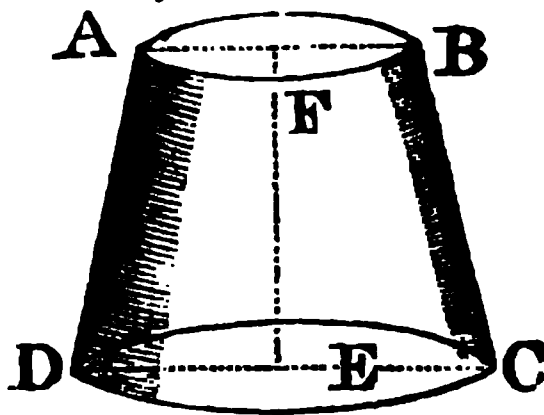
EXAMPLE. Required the number of beer gallons contained in a pyramid DEFGK (See fig. Prob. X. Example I.) whose base is a square EFGK. a side of which, as EF, is equal to 30 inches, and the perpendicular height of the pyramid is 60 inches ? The square of 30 is the area of the base 900, this multiplied by one-third of the altitude 20, gives the solidity 18000, which divided by 282, gives the answer in beer gallons 63.8.

PROBLEM V.

To find the number of gallons or bushels contained in a body of the form of a frustum of a cone. (See the figure below.)

RULE. Multiply the top and bottom diameters together, and to the product add one-third of the square of the difference of the same diameters : multiply this sum by the perpendicular height, and divide the product by 294.12 for wine gallons, by 359.05 for ale gallons, and by 2738 for bushels.

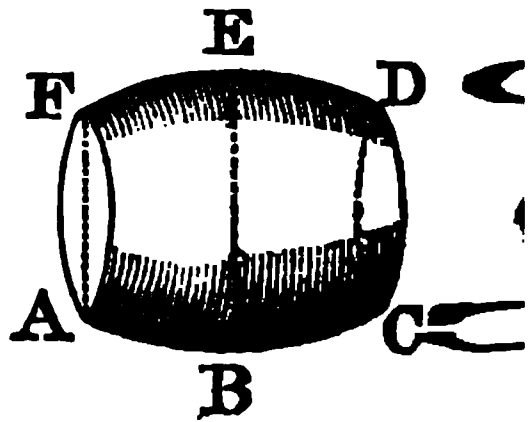
EXAMPLE. Given the diameter DC of the bottom of a frustum of a cone 36 inches, the top diameter AB=27 inches, and the perpendicular height, FE 50 inches. Required the content in wine gallons ? The product of the two diameters 36 and 27 is 972 ; their difference is 9, which squared and divided by 3 gives 27 ; this added to 972 gives 999, which multiplied by the height 50 gives the solidity 49950 ; this divided by 294.12 quotes the content in wine gallons 169.



PROBLEM VI.

To gauge a cask.

To gauge a cask, you must measure the head diameters FA, DC, and take the mean of them when they differ ; measure also the diameter EB at the bung, (taking the measure within the cask) ; then measure the length of the cask, making due allowance for the thickness of the heads. Having these dimensions, you may calculate the content in gallons or bushels, by the following rule.



GAUGING.

199

RULE. Take the difference between the head and bung diameters, multiply this by .62 and add the product to the head diameter, the sum will be the mean diameter; multiply the square of this by the length of the cask, and divide the product by 294.12 for wine gallons, by 359.05 for beer gallons, and by 2738 for bushels.

The quantity .62 is generally used by gaugers in finding the mean diameter of a cask; but if the staves are nearly straight, it would be more accurate to take 55 or less;* if, on the contrary, the cask is full on the quarter, it would be best to take .64 or .65.

EXAMPLE. Given the bung diameter $EB=34.5$ inches, the head diameter $FA=DC=30.7$ inches, and the length 59.3 inches; required the number of wine gallons this cask will hold? The difference of the two diameters 34.5, and 30.7, is 3.8; this multiplied by .62 gives 2.4 nearly, to be added to the head diameter 30.7 to obtain the mean diameter 33.1. The square of 33.1 is 1095.61, this multiplied by the length 59.3 gives the solidity 64969.673, which, divided by 294.12, quotes the content in wine gallons 220.8.

To gauge a cask by means of the line of numbers on Gunter's Scale, or on the calipers used by gaugers.

Make marks on the scale at the points 17.15, 18.95, and 52.33, which numbers are the square roots of 294.12, 359.05, and 2738, respectively. A brass pin is generally fixed on the calipers at each of these points, which are called the gauge points. Having prepared the scale in this manner, you may calculate the number of gallons or bushels by the following

RULE. Extend from 1 towards the left hand to .62, (or less if the staves be nearly straight) that extent will reach from the difference between the head and bung diameters, to a number to the left hand, which added to the head diameter will give the mean diameter; then put one foot of the compasses upon the gauge point—which is 17.15 for wine gallons, 18.95 for ale gallons, and 52.33 for bushels—and extend the other to the mean diameter; this extent turned over twice the same way, from the length of the cask, will give the number of gallons or bushels respectively.

In the preceding example the extent from 1 to .62 will reach from 3.8 to 2.4 nearly, which added to 30.7 gives the mean diameter 33.1.

Then the extent from the gauge point 17.15 to 33.1, turned over twice from the length 59.3, will reach to 220.8 wine gallons.

If you had used the gauge point 18.95, the answer would have been in ale gallons; and if you had used 52.33, the answer would have been in bushels.



SURVEYING.

LAND is generally measured by a chain of 66 feet in length, divided into 100 equal parts called links, each link being 7.92 inches.

A pole or rod is $16\frac{1}{2}$ feet, or 25 links, in length; hence a square pole contains 272 $\frac{1}{4}$ square feet, or 625 square links.

An acre of land is equal to 160 square poles, and therefore contains 43560 square feet, or 100,000 square links.

To find the number of square poles in any piece of land, you may take the dimensions of it in feet, and find the area in square feet, as in the preceding Problems; divide this area by 43560, the quotient will be the number of acres: or by 272.25, and the quotient will be the number of square poles. If the dimensions be taken in links, and the area be found in square links, you may obtain the number of acres by dividing by 100000 (that is, by crossing off

* In the example to Problem V. preceding (which may be esteemed as the half of a hoghead with staves perfectly straight) the multiplier is only .51. For this multiplied by 3, the difference between AB and DC, produces 4.59 or 4.6 nearly, which, added to 27, and the sum 31.6 squared, multiplied by 50 and divided by 294.12 quotes 169 gallons nearly.

the five right hand figures :) and the number of square poles may be obtained by dividing by 625.

PROBLEM I.

To find the number of acres and poles in a piece of land in the form of a rectangular parallelogram.

RULE. Multiply the base by the perpendicular height, and divide by 625, if the dimensions were taken in links, but by 272.25, if they were taken in feet; the quotient will be the number of poles, which, divided by 160, will give the number of acres.

EXAMPLE I. Suppose the base DB (see the figure of Ex. I. Prob. I. of Mensuration) of the rectangular parallelogram ACBD is 60 feet, and the perpendicular BC 25 feet; required the area in poles?

The product of the base 60 by the perpendicular 25 gives the content 1500 square feet, and by dividing by 272.25, we obtain the answer in square poles 5.5.

PROBLEM II.

To find the number of acres and poles in a piece of land in the form of an oblique-angular parallelogram. (See the figure of Prob. I. Ex. IV. of Mensuration.)

RULE. This area may be found in exactly the same manner as in the preceding Problem, by multiplying the base AD by the perpendicular height BE, and dividing by 625, when the dimensions are taken in links, but by 272.25 when taken in feet; the quotient will be the answer in poles, which divided by 160 will give the answer in acres.

EXAMPLE. Suppose the base AD is 632 links, and the perpendicular BE 326 links; required the number of poles?

Multiply the base 632 links by the perpendicular 326 links, the product 206032 divided by 625, gives the answer in poles 329.

PROBLEM III.

To find the number of acres and poles in a piece of land of a triangular form.

RULE. Multiply the base by the perpendicular height, and divide the product by 1250 when the dimensions are given in links, but by 544.5 when they are given in feet; the quotient will be the answer in poles.

NOTE. Instead of dividing by 1250, you may multiply by 8, and cross off the four right hand figures.

EXAMPLE. Given the base AC (see fig. of Prob. II. of Mensuration) equal to 300 feet, and the perpendicular BD 150 feet; required the area in poles?

Multiply the base 300 by the perpendicular 150, the product 45000, divided by 544.5, quotes the answer in poles 82.6.

PROBLEM IV.

To find the number of acres and poles in a piece of land of any irregular right-lined figure.

RULE. Find the area as in Problem III. of Mensuration, by drawing diagonals, and reducing the figure to triangles: the base of each triangle being multiplied by the perpendicular, (or by the sum of the perpendiculars falling on it) and the sum of all these products divided by 1250 when the dimensions are given in links, but by 544.5 when in feet, will give the area of the figure in poles.

EXAMPLE. Suppose that the piece of land is of the same form as the figure in Prob. III. of Mensuration, and that EB=22 feet, EC=33 feet, AF=13 feet, BG=14 feet, and DH=12 feet: it is required to find the area in poles?

The product of EB 22 feet, by AF 13 feet, gives double the triangle EAB 286 square feet; and the diagonal EC 33 feet, multiplied by the sum of the perpendiculars BG, DH, 26 feet, gives double the figure BCDE, 858 square feet; the sum of this and 286, divided by 544.5 gives the area 2.1 or $2\frac{1}{10}$ poles.

the sum of the Diff. of Lat. is 21.2, and the sum of the departure 36.0: but it more frequently happens that the numbers do not agree; in which case the work ought to be carefully examined, and if no mistake can be found, and the error is great, the place ought to be surveyed again; but if the error be small, it ought to be apportioned among all the differences of latitude and departure, in such manner as to produce the required correction with the least possible changes in the given numbers. The method of doing this was explained by me in the fourth number of the Analyst, in answer to a private question of Professor Patterson, and is as follows. Find the error in latitude, or the difference between the sums of southing and northing, also the sum of the boundary lines, AB, BC, &c. Then say, as this sum is to the error in latitude, so is the length of any particular boundary to the correction of the corresponding difference of latitude, additive if in the column whose sum is the least, otherwise subtractive. The corrections of the departure are found by the same rule, except changing diff. of lat. into departure. Thus in the adjoined example, the sum of the boundary lines is 161.6, the error of latitude is 0.10 and of departure .08,

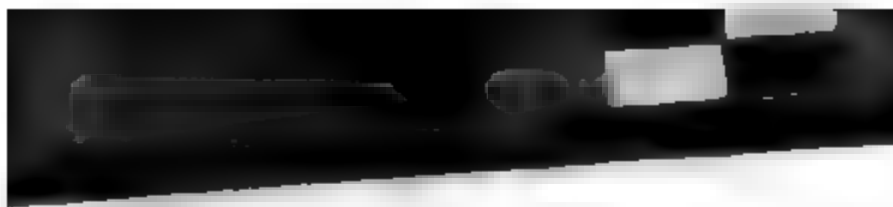
Bearings	Lengths	N.	S.	E.	W.	Corrections.		Corrected values.			
						N.	E.	N.	S.	E.	W.
N. 45° E.	40.	28.28		28.28		.02	.02	28.30		28.30	
S. 30 W.	25.		21.65		12.50	.02	.01		21.68		12.49
S. 6 E.	38.		35.86	5.14		.02	.02		35.84	5.16	
W.	29.6				29.60	.02	.01	0.02			29.59
N. 30 E.	31.	29.13		10.60		.02	.02	29.15		10.62	
	161.6	57.41	57.51	42.02	42.10	.10	.08	57.47	57.47	42.04	42.08
		Error	.10	Error	.08						

and the corrections of the diff. of lat. and departure are found by the following proportions:

		Lat.				Dep.	
161.6	: 0.10	40	: 0.02*	16.16	: 0.08	40	: 0.02
		25	: 0.02			25	: 0.01
		38	: 0.03			38	: 0.02
		29.6	: 0.02			29.6	: 0.01
		31	: 0.02			31	: 0.02

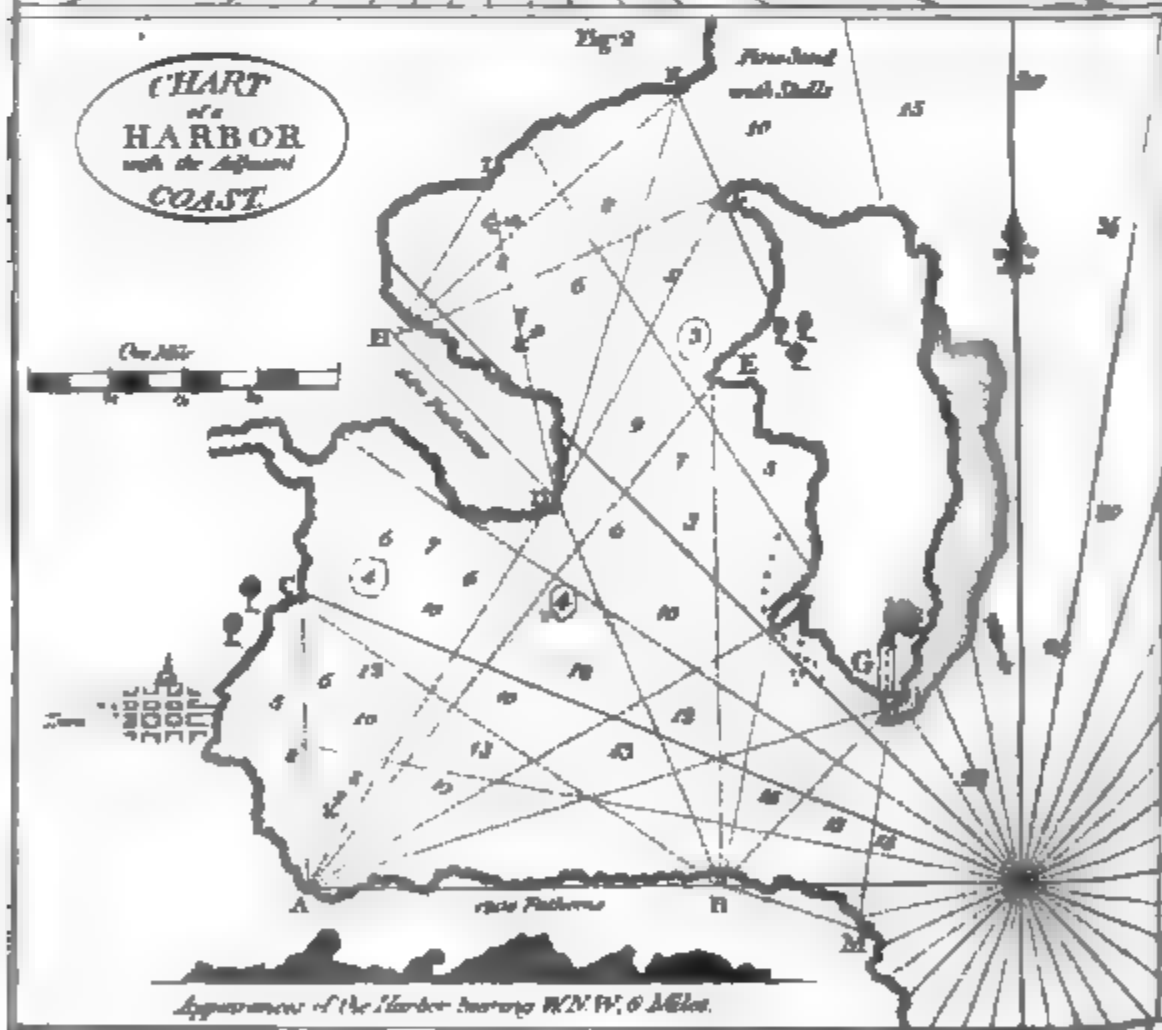
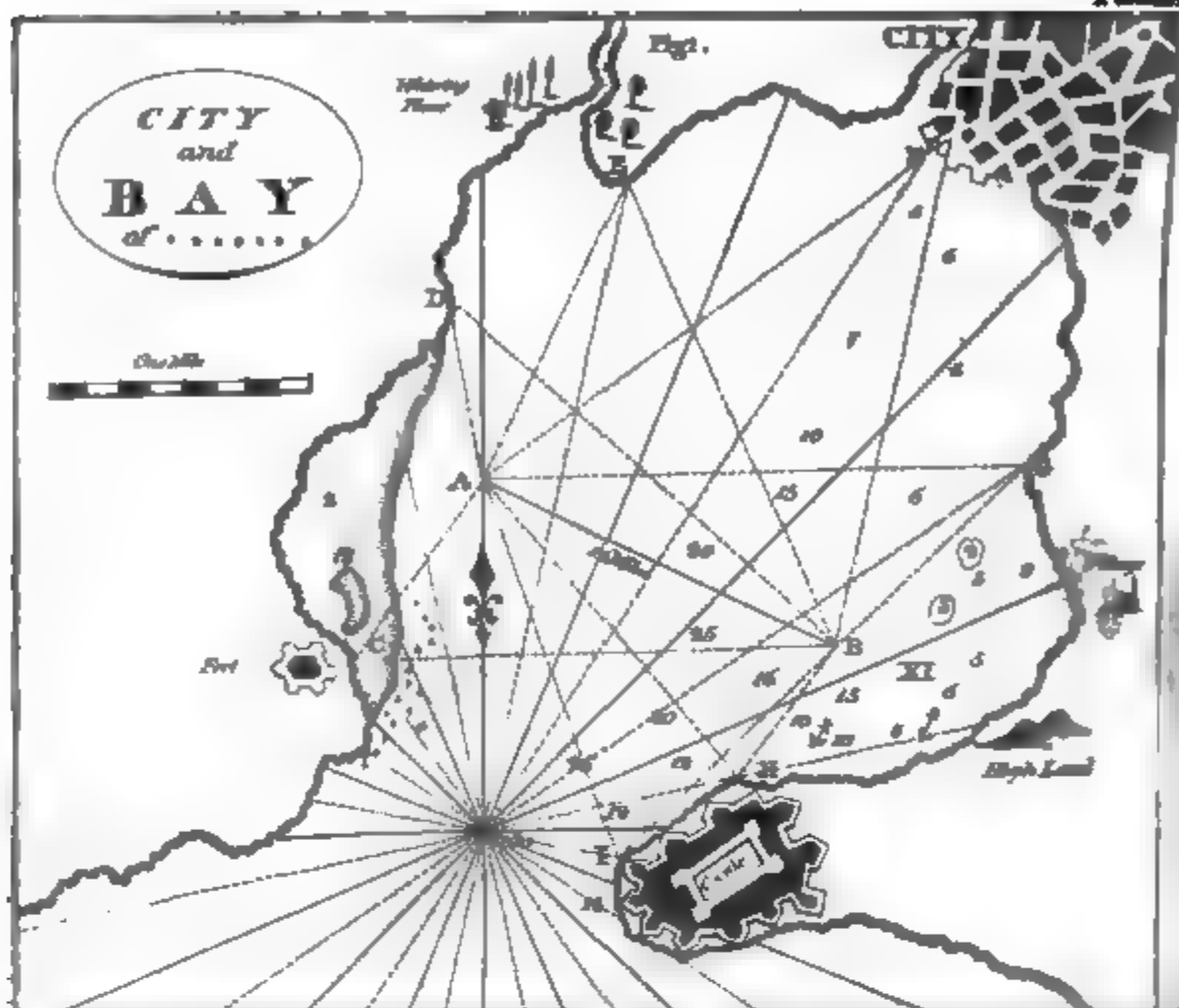
The first correction of lat. .02 is to be added to the first latitude, 28.28, because it is in the column whose sum 57.41 is less than the other 57.51, so that the first corrected diff. of lat. is 28.30. The second is the difference between 21.65, and the second correction .02, because 21.65 is in the greatest column, the corrected value is therefore 21.63. The third is found in the same manner to be 35.86—.02=35.84. The fourth corrected difference of latitude is simply the fourth correction .02 placed in the column N, because the sum in that column, 57.41 is the least and the fourth diff. of latitude in the original table is 0. The fifth is the sum of 29.13 and the fifth correction 0.02, making 29.15. These are placed in their proper columns in the corrected values. In a similar manner the first departure is equal to the sum of 28.28 and the first correction 0.02, which is equal to 28.30. The second is the difference between 12.50 and the second correction .01, making 12.49 and so as for the others, taking the sum when the departure is in the column whose sum is the least, which in the present case is the east, and the difference when in the other column. In the traverse table thus corrected, the sum of the differences of latitude is 57.47 in both columns, and the sum of the departures 42.08. Having corrected the values of this traverse table you must find the meridian distances, the column M, the north and south areas, &c. as in the former example.

* The boundary lines in this example are so nearly of an equal length that the correction of the difference of latitude (taken to the nearest decimal) is 0.02 for each of them, but in general, they will be different. The table of difference of latitude and departure may be made use of in finding these corrections, thus: seek in the table till the first term 161.6 (or 162) is found in the distance column to correspond in the second term .10 (or 10) in the departure column, thus opposite the third term .40, 25, &c. will be the sought corrections, as is evident.



SURVEYING.

Fig. 1.



Appearance of the Harbor bearing WNW, 6 Miles.

CHART BY W. H. PIER.

In projecting a survey of this kind, where there is a small error, you do not plot off as usual the boundary lines AB, BC, CD, &c. and it will be manifest that the termination of the last line EA will not fall exactly in the line AB, but will be at a point near it, which we shall call *a*. To correct this error you must draw through the points B, C, D, &c. lines parallel to *aA*, in the direction from *a* to A, of such lengths as to be to *Aa*, as the distances of those points respectively from A (measured on the boundary ABCD, &c.) to the whole length of the boundary line, through these points draw the corrected lines terminating on A. Want of room prevents entering into farther explanation of the subject.

The manner of surveying Coasts and Harbours.

From what has been said in the preceding problems, the intelligent reader will readily perceive the method of surveying a coast or harbour; but as this is an important subject, it was thought proper to enter more fully into explanation of the different methods to be made use of.

To take a draught of a coast in sailing along shore.

Having brought the ship to a convenient place, from which the principal points of the coast, or bay, may be seen, either cast anchor, if it is convenient, or lie-to as steady as possible; or if the coast is too shoal, let the observations and measures be taken in a boat. Then while the vessel is stationary, take with an azimuth compass the bearings in degrees of such points of the coast as form the most material projections or hollows;* write down these bearings, and make a rough sketch of the coast, observing carefully to mark the points whose bearings are taken, with letters or numbers, for the sake of reference.

Then let the ship or boat run in a direct line, which must be very carefully measured by the log, or otherwise, one, two, or three miles, until she comes to a situation from which the same points before observed can be seen again with quite different bearings: then let the vessel lie steady as at the former station, and observe again the bearings of the same points, and make a rough sketch of the coast; this sketch may be made more accurately while the vessel is running the base line.

To describe the chart from these observations, you must in some convenient part of a sheet of paper draw the magnetic meridian, and lay off the several bearings taken at the first station, marking them with their proper letters or numbers; lay down also the bearings taken from the second station. Draw a line to represent the ship's run both in length and course, and from that end of the line expressing the first station, draw lines parallel to the respective bearings taken from that end; also from the other end draw lines parallel to the bearings taken at that end, and note the intersection of each pair of lines directed to the same point; and through these intersections draw by hand a curved line, observing to wave it in and out as far as can be like the trending of the coast itself. Then mark off the variation of the compass from the north end of the magnetic meridian towards the right hand, if it be west, or towards the left hand if it be east, and draw the true meridian through that point and the centre of the circle. Against each part draw the appearance of the land marked in the sketches, distinguishing the rocky shore, highland, beach, &c. as in Plate V. or XI. Thus the sand beaches may be marked as in Plate XI. fig. 8, and the rocky shore as in fig. 9, &c. Put in the several soundings at low water,† in small figures, distinguishing whether they are fathoms or feet; show the time of high water on the full and change days by Roman figures, and tell the rise of the tide in feet. The direction and velocity of the flood tide are to be observed, which may be done by heaving the log when the ship or boat is at

* In taking the bearings, if the vessel has much motion, the mean of several observations should be taken.

† If the soundings were not taken at low water, they may be reduced thereto by a method which will be explained hereafter.

anchor, and the direction is to be represented by an arrow. Put in a compass and a scale of miles or leagues such as the vessel's run was laid down by; add the name of the place, and the latitude and longitude as true as can be obtained.

If there are shoals or sands on the coast, let them be taken in a boat, sailing round them, keeping account of the courses, distances, and soundings.* But to put them in the draught, the observer in the boat must take the bearings of two points on the coast (the bearings of which have been taken from the ship) from some part of each sand or shoal, so sailed round; or, the bearing of the boat at some part of the shoal, or of some beacon in that place, must be taken by the ship at each of the stations where the bearings of the shore were taken from the ship; for by either of these means, one point of the sand being obtained, the rest of it can be laid down from the observations taken in the boat. Rocky shoals may be marked on the chart, as in Plate XI. fig. 11, and sand banks as in fig. 10.

If the coast to be drawn is a bay or harbour winding in such manner, that all its parts cannot be seen at two stations, let as many bases or lines be run and measured exactly as may be found necessary, observing that the several distances run should join to one another, in the nature of a traverse; that each new set of objects, or points observed, should be taken from two stations at the ends of a known distance, and that the objects whose bearings are taken do not so much extend beyond the limits of the base as to make angles with it less than about $\frac{1}{2}$ or $\frac{3}{4}$ of a point, but rather reserve such objects for the next measured base line; for when lines lie very obliquely to one another, their intersections are not easily ascertained.

If any particular parts of the harbour cannot be conveniently seen from either of the stations, take the boat into those places, and having well examined them, made sketches thereof, estimating the lengths and breadths of the several inlets, either by the rowing or sailing of the boat, take as many bearings, soundings, and other notes, as may be thought necessary; then annex these particular views in their proper places, in the general draught.

If there are any dangerous sands or rocks, besides inserting them in their proper places, you must see if there be any two objects ashore (such as a church, mill, house, noted cliff, &c.) which appear in the same right line when on the shoal; and these objects must be noted on your chart. If none can be found, you must take the bearings of some remarkable points, and note them on your chart; by which means it will be known how to avoid the danger.

It should be remarked in the draught the kind of bottom obtained in sounding, whether mud, sand, shells, coral, rocky ground, &c.; and where there is good anchorage draw the figure of an anchor. Also, if there is any particular channel more convenient than another, it is to be pointed out by lines drawn to its entrance from two or more noted marks ashore.

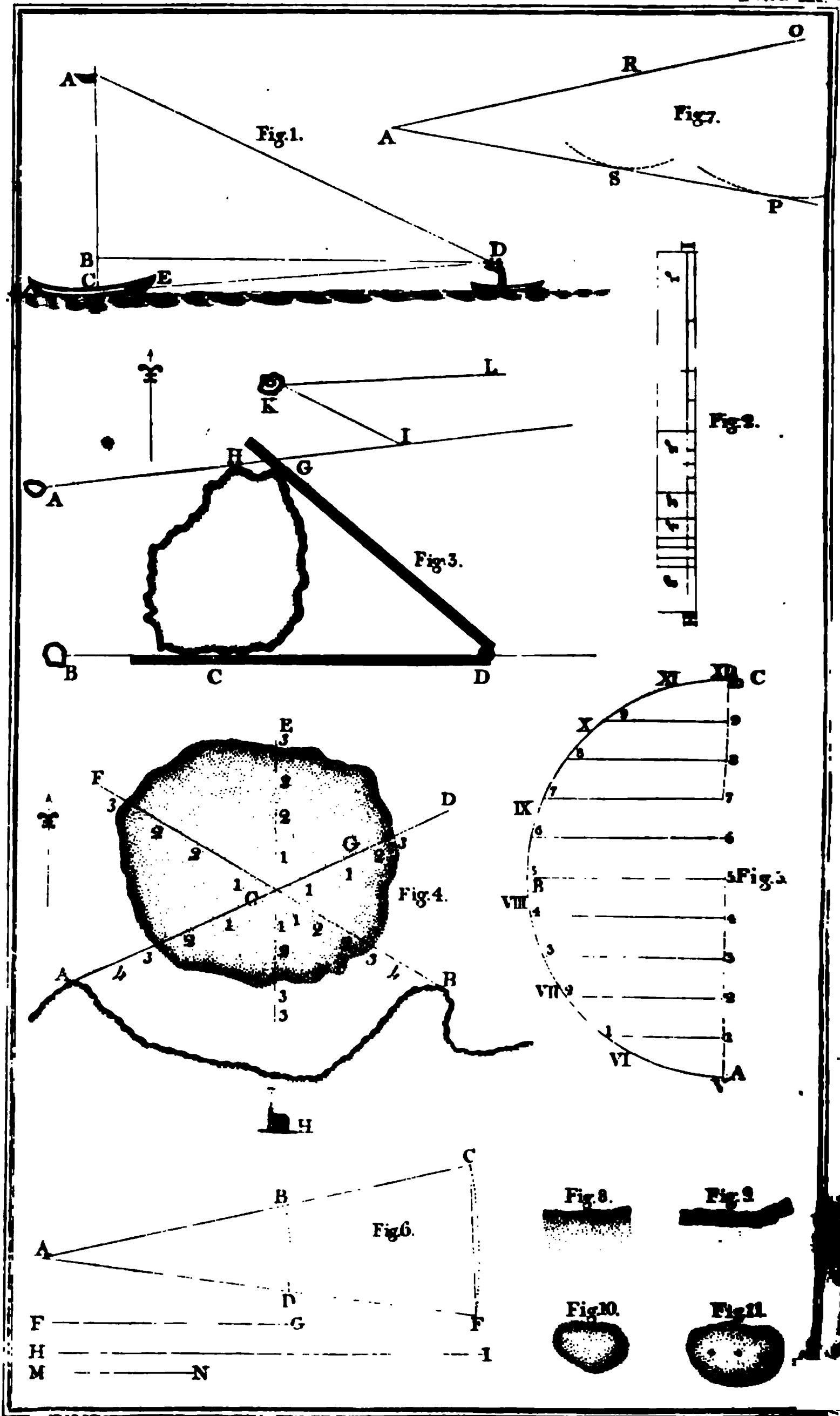
The positions of objects taken by a magnetic compass being liable to great uncertainties, as is well known to those who have had any experience, especially at sea; it has therefore been recommended to observe only the bearings of the station lines by the compass, and then measure the angles which the other objects make with these lines, by a quadrant or sextant, which for this purpose must be held in an horizontal position.

EXAMPLE I. (See fig. 1, Plate X.

Suppose a ship at A observes the bearings of the most remarkable point of a bay, C, D, E, F, G, H, and I, and sails S. 64° E. $1\frac{1}{2}$ miles to B; at B

* It is difficult to ascertain correctly the courses and distances sailed by the boat, on account of the currents and other causes. This inconvenience may be obviated if the ship be at anchor, and not far from the boat, by observing in the boat the bearing of the ship by compass, and by measuring, with a quadrant, the angle contained between the top-gallant-mast head, and that part of the ship which is at the same height as the eye of the observer; for by this angle the distance of the boat from the ship may be determined, as will be explained in this work.





she also observes the bearings of the same points ; hence it is required to construct the chart.

Bearing of C from A	S. 36° W.
D	N. 9° W.
E	N. 26° E.
F	N. 55° E.
G	East.
H	S. 40° E.
I	S. 19° E.

Bearing of C from B	S. 89° E.
D	N. 48° W.
E	N. 24° W.
F	N. 13° E.
G	N. 47° E.
H	S. 38° W.
I	S. 46° W.

Draw the line AB, S. 64° E. 1½ miles. Through the points A and B draw the lines AC, AD, AE, AF, AG, AH, AI, BC, BD, BE, BF, BG, BH, and BI, at their respective bearings, and where the corresponding lines cut each other, will be the points C, D, E, F, G, H, and I, required ; through which the different curvatures of the land must be drawn, corresponding with your eye-draught. In this manner may a chart be constructed by observations taken upon the water. The manner of surveying upon land is exactly similar.

To survey a harbour by observations on shore.

Make an eye-draught of the place to be surveyed, and in going round the coast fix station staves, or straight poles, tall enough to be seen at a considerable distance, in the most remarkable points and bendings of the shore ; but if at any of those places there is a noted tree, house, or any other remarkable thing, that object may serve instead of a station staff ; and it will be convenient to black the staves, and tie a piece of white bunting at the top of each ; then in the eye-draught put letters or numbers at the noted points or marks for the sake of distinction.

Choose the most extensive and level spot of ground you can meet with to measure your base line upon, which should not be less than a tenth part of the distance of the two extreme objects which are to be observed ; and let the direction of the measured base line be such, that as many of the station staves as possible may be seen from each end of it. The bearing or position of this base must be well determined in degrees and minutes, and the length accurately measured, either by a measuring chain or a piece of log-line.

From each end of the base observe, with an azimuth compass, or with a Theodolite, if it can be procured, the bearings of each of the station staves ; or else with a sextant measure the angles contained between the staves or remarkable objects, and the other end of the station line, and write them down in order in your book. These measures and angles being plotted down as before directed, will give the most conspicuous points of the shore, the intermediate spaces are to be filled up from the sketches made on the spot.

But if either of these objects should spread on either hand so far beyond the limits of the base, that at either end thereof the other end and those objects should appear nearly in the same direction, or to make angles not exceeding 10° : or, if some of the remarkable objects could be seen only from one end of the base ; then let the bearings of such objects be taken from a place whose position has been determined from both ends of the measured base ; or, if there are several remarked objects which cannot be seen from either end of the base lines, let the bearings of such objects be taken from each of two points whose positions have been determined by bearings taken from both ends of the base, or it may, on some occasions, be proper to choose another place on which another base of a convenient length may be measured, and from the extremities of which the ends of the first base may be seen ; and as many as can be of the remaining objects which lay too obliquely, or which could not be seen from the first base. In such manner proceed until the bearings are taken of all the points judged necessary for completing the survey of the limits of the harbour.

If a right line of a sufficient length for a base line cannot be measured, it may be taken in two adjoining lines as the two sides of a triangle, the included angle being accurately taken, and the bearing of either line.

When the outlines or limits of a harbour, bay, road, &c. are delineated, by the preceding precepts, let a small vessel go out to sea to take drawings of the appearance of the land and its bearings; sail likewise into the harbour, and draw the appearance of its entrance; take particular notice if there be any false resemblance of the entrance, by which ships may be deceived and run into danger; or when any two objects being brought in a line, or in one, will lead into the harbour without danger; search for the best anchoring places, and if possible, denote those places by bringing two objects in one, if not, take the exact bearings of two or three other objects, so that the places may be easily determined. The chart being correctly drawn, a compass, with the variation, and scale properly fitted to the plan, the islands, rocks, sands, &c. must be marked in their proper places, with their soundings at low water, the anchoring places, with the best track to get to them; the proper sailing marks to avoid dangers; the places where fresh water can be got; the name of the place, the country in, on what sea; the latitude and longitude; a sketch of the appearance the place makes at sea upon a known bearing, and at an estimated distance; and whatever else a judicious seaman shall think proper may be inserted. Then will the plan be fit for all nautical purposes, and may be embellished with proper colours if necessary.

EXAMPLE II. (See fig. 2. Plate X.)

From each end of a base line AB of 1200 fathoms, were observed the points C, D, E, F, and G; and as the points I, K, and L, were not visible from the extremities of the base line, another base line was measured from the point D to H of 650 fathoms, from which points the bearings of I, K, and L, were observed: hence it is required to construct a chart of the place.

Bearing of B from A	East.	Bearing of C from B	N. W. b. W.
C	North.	D	N. N. W.
D	N. E. b. N.	E	North.
E	N. E. $\frac{1}{2}$ N.	F	N. b. E.
F	N. E. b. E. $\frac{1}{2}$ E.	G	N. E.
G	E. b. N. $\frac{1}{2}$ N.		
Bearing of H from D	N. W.	Bearing of I from H	N. E. by N.
I	N. b. W.	K	N. E. $\frac{1}{2}$ E.
K	N. b. E. $\frac{1}{2}$ E.	L	E. N. E.
L	N. N. E. $\frac{1}{2}$ E.		

Draw the east line AB=1200 fathoms; from each end of this line draw the lines AC, AD, AE, AF, AG, BC, &c. at their respective bearings; the points of intersection will give the points C, D, E, F, and G. From the point D (which was found in this manner) draw the N. W. line DH=650 fathoms: and through these points draw the lines DI, DK, DL, HI, &c. at their respective bearings; the points of intersection of the corresponding lines will be the situation of the points I, K, L. Between these remarkable points, draw the outlines of the land, conformable to your rough draught.

In order to determine the situation of the point M, which was seen too obliquely from the bases AB, DH, you may take the bearing of that point from B, and then from G (whose situation has been determined by bearings taken from the points A, B,) the intersection of the lines BM, GM, will determine the situation of M.

Method of surveying a small bank or shoal where great accuracy is required.

The method of determining the extent and situation of shoal ground by sailing round it and keeping an account of the courses and distances sailed is well adapted to the taking of an extensive survey, or to the exploring a large bank, where great accuracy is not required; but the difficulty of certaining with precision the courses and distances sailed (which are liable to error on account of the tides, currents, and the different velocity of boat at different times owing to the unsteadiness of the wind) prevents method from being sufficiently accurate to be used in exploring a dangerous shoal or bank at the entrance of a narrow channel of a harbour, or other place where the exact form of the shoal is to be found; and if to

tain the necessary degree of correctness, the bearings of two remarkable objects were taken at every time of sounding, the time expended in taking the observations would be increased beyond all reasonable bounds. To obviate these difficulties, the following methods may be made use of, by either of which the necessary observations for determining the situation of the boat, may be made as fast as the soundings can be taken.

First Method. Procure a large sail-boat with a high mast, and a small row-boat; bring the sail-boat to anchor on the bank which is to be explored, and take accurately the bearings of two remarkable points of land, or other objects whose situation has already been determined by observations taken on shore, or in sailing along the land; by this means the situation of the sail-boat may be accurately marked on the chart; then enter the small boat and row from the other in any particular direction, observing to keep the mast of the boat to bear upon any point of the compass, or (which is much more accurate) to keep the mast of the boat to range on any particular point of land, or other object marked on the chart; by these means any errors which might arise in the course of the boat will be entirely prevented. While proceeding in this direction let one person take the soundings, while another observes with a quadrant or sextant the angular elevation of the top of the boat's mast above the horizontal line drawn from the eye of the observer, and a third person notes the observations in the minute book, and the time of observation, in order to make the necessary reduction in the soundings to reduce them to low water. Proceed in this manner from the sail-boat till you get off the bank into deep water, or till the elevation of the mast is not much less than one degree, then row across the bank till the bearing of the mast is altered considerably, or till it appears in a range with another point of land at a considerable angular distance from the point with which the mast ranged in the first observations; then row towards the boat, sounding and observing the angular elevation of the mast as before. Proceed in this manner in sounding to and from the sail-boat till you have procured a sufficient number of soundings in every direction. Then go on board the sail-boat and shift her birth to another part of the bank where soundings have not been taken and proceed to sound as before. Continue sounding and shifting the situation of the boat, till the whole bank has been explored, and then the observations may be plotted off by the directions in the following example.

Let ABC (Plate XI. fig. 1.) be the mast of the sail-boat, D the situation of the eye of the person who observes the angular elevation of the mast. Draw the line DB parallel to the horizon and join DA. Then the height AB must be measured* accurately, and that being given and the observed angle ADB the corresponding distance BD may be obtained by the usual rules of trigonometry by saying as radius : AB :: co-tangent ADB : BD. Thus if the height AB was 50 feet, and the angle ADB 1° , the distance BD would be 1719 feet (being 57.3 times as great as AB). The distances corresponding to 2° , 3° , &c. are given in the adjoined table, by examining which it will appear that the distance BD corresponding to any angle ADB (less than 30°) may be obtained nearly by dividing 1719 by the angle ADB in degrees. Thus for 4 degrees the distance by this rule would be $1719 \div 4 = 429\frac{1}{2}$, nearly, as in the table. The greatest difference between the distances determined by the rule and by the table being 5 feet, corresponding to the angle 30° , for $1719 \div 30 = 57\frac{1}{2}$; whereas, by the table the distance is 52. In taking soundings by this method it will be very rarely necessary to measure an angle so great as 30° , so that for all practical purposes the distance may be de-

ADB	BD
	feet.
1°	1719
2	859
3	572
4	429
5	343
10	170
20	85
30	57

* A mark may be made at D, and a vane placed at the top of the mast at A, to enable the observer to distinguish these objects when at a great distance. If the height of the observer above the horizon be small in comparison to the height of the mast, the angular distance ADE between the surfaces of the sea and the top of the boat's mast might be measured, instead of ADB; for if the distances BD, and CE, remained the same in all observations, it would be immaterial which angle was

terminated in this example to a sufficient degree of accuracy by dividing 1719 by the observed angular elevation in degrees. On these principles we have the following rule for calculating the distance corresponding to a mast of any given height, and to any observed angular elevation.

RULE. *Multiply the height of the mast above the eye of the observer by 57.3, and the product will be a constant quantity* which being divided by the observed angle of elevation expressed in degrees and decimals of a degree, the quotient will be the sought distance nearly.*

If the height of the mast be expressed in equal parts taken from the scale by which the chart was plotted off, the distances found by the above rule would be expressed in the same equal parts; so that if the distances thus expressed corresponding to 1° , 2° , 3° , &c. were calculated and marked on a slip of paper (fig. 2, Plate XI.) from H to 1° , from H to 2° , from H to 3° , &c. respectively, the slip HI thus marked, would be a very convenient scale for plotting off such distances.

For further illustration of this method, we have given an example in fig. 4, Plate XI. in which C represents the place at which the sail-boat was at anchor, A and B the points observed, in order to ascertain her position on the chart, by drawing thereon the lines AC, BC, in opposite directions to the bearings of the points A, B, observed from the boat; for the point of intersection C will evidently be the place of the boat upon the chart. Suppose now that in the first set of observations the mast of the sail-boat was made to range on the point A, in this case the course of the boat must be on the continuation of the line AC towards D, then the slip HI (fig. 2, Plate XI.) is to be laid upon the line CD (fig. 4, Plate XI.) with the point H upon C, and the angular elevation being found on the slip the sounding corresponding (reduced to low water) is to be marked on the line CD, immediately under the mark on the slip. Thus if the angle was 4° , the point corresponding would be G. Having plotted off the soundings taken in the direction CD, proceed in the same manner with the others, viz. those in the direction CE found by keeping the boat's mast in a range with the church at H, those in the direction CF found by keeping the boat's mast in a range with the point B, those in the direction CA found by keeping the mast to bear E. N. E. and so on with the other observations; and when all the soundings are marked on the chart, dotted lines are to be made round the shoal soundings, and thus the true figure of the shoal part of the bank will be obtained.

This method I have frequently used in taking a survey of the part of the coast of Massachusetts' Bay, included between Manchester and Lynn. The height of the mast of the boat used on the occasion was about 30 feet, and it was found that distances less than a third of a mile could be obtained in this manner to a great degree of precision.

Second Method. This method of determining the place where soundings were taken consists in keeping (while sailing in a boat and sounding) a particular point of land, or any other object, to bear always in the same direction, and measuring with a quadrant or sextant held in a horizontal position the angular distance between that object and another object (making a considerable angle with the former) for by this means the situation of the boat at the time of sounding may be determined. Instead of bringing the object to bear upon a particular point of the compass, you may (when it can be

measured; observing however that different scales must be used for plotting off the angles ADE and ADE.

If AB represented the known vertical height of the summit of an island above the eye of an observer, the distance from the island might be determined by measuring the angular elevation ADB, as is evident from what has been said above.

* This constant quantity may be determined without actually measuring the altitude AB. If the angular elevation can be measured at a place D where the distance BD is known. Thus is the example (Plate XI. fig. 4) the distance AC being known, and the angular elevation of the mast at C being observed at A in degrees and decimals of a degree, and multiplied by the distance AC, the product will be the constant quantity mentioned in the rule. This method may be used in determining the distance from an island by the method mentioned in the last note.

done) bring the object in a range with another remarkable object, and by this means you will avoid the error which might arise from the use of a compass.

For an example of this method, suppose that a survey of the small islands A, B, K. (Plate XI. fig. 3) and the large one CHG had been taken and plotted off as in the figure. Then soundings may be taken in the direction BCD by bringing the small island B in a range with the southern part of the great island, and measuring the angle CDG formed by the extremes of the great island; or by keeping the small island A to range with the northern part of the great island, and measuring the angle HIK formed by the northern extreme of that island, and the small island K; or by running in the direction KL so as to keep the island K to bear W. $\frac{1}{4}$ S. and measuring the angle formed by that island and the northern extreme of the great island, &c.

The method I have generally used for plotting off such angles is by means of a sector; and as that instrument is more easily procured than others better adapted to the purpose, I shall explain the method by showing how the angle CDG, measured as above, may be plotted off so as to determine the point D where that angular distance was observed. To do this, you must draw the line DC, and open the sector till the two legs form with each other an angle equal to the observed angle CDG, then slide one leg of the sector on the line DC till the other leg touches the northern extreme of the island at the point G, and the point directly under the centre of the joint of the sector will be the point of observation: as this point cannot be exactly marked on account of the size of the joint of the instrument, you may mark with a pencil on the line DC the top points where the circumference of the joint touches that line, and note the sounding in the middle between those two marks.

If a quadrant of a circle be described on a piece of paper, with a radius equal in length to one of the legs of the sector, and then divided into 90° , the sector may, by means of that quadrant, be opened to any angle in a very expeditious manner.

This method of obtaining distances when sounding, I have frequently used with success.

To reduce soundings taken at any time of the tide to low water.

The soundings at low water are always to be marked on a chart, and if they are taken at any other time of the tide, a proper allowance must be made to reduce them to low water. This allowance may be made if the whole vertical rise of the tide from low to high water be known, and the time of high and low water, as in the following example.

Suppose the vertical rise of tide from low to high water, to be 10 feet, the time of low water 5h. A. M. and the time of high water 11h. 30m. A. M.: required the allowance to be made on an observation taken at 8 A. M.?

Draw the line AC (Plate XI. fig. 5) and make it equal to the whole rise of the tide 10 feet, taken from any scale of equal parts, and divide the line into equal parts representing feet, at the points 1, 2, 3, &c. to 10, the mark 10 (corresponding to the whole rise of the tide) being at the point C, and through these points draw lines 11, 22, 33, &c. perpendicular to AC, to meet the circumference of a circle drawn on the diameter AC. Divide the semi-circumference ABC of that circle into a number of equal parts representing the number of hours elapsed from low to high water,* which in this case is 6 $\frac{1}{2}$ h. the hour of low water being marked at A, and that of high water at C, the intermediate hours being marked in succession as in the figure:

* This division of the semi-circle may be made by means of a line of chords. The number of degrees corresponding to one hour being found by saying, as the whole elapsed time from low to high water (6 $\frac{1}{2}$ hours) is to 180° so is one hour to the arch corresponding to 1 hour $27^\circ 42'$, which being taken from a line of chords and laid off from 5h. will reach to 6h. &c.

then any hour being found on the arch, the number of the line drawn perpendicular to AC, and passing through the hour, will represent nearly the number of feet to be subtracted from a sounding taken at that time to reduce that sounding to low water. Thus the number of feet corresponding to 8h. is between 4 and 5, because the mark 8h. falls between the lines marked 4 and 5, so that the reduction is between 4 and 5 feet, on soundings taken at 8 A. M. to reduce them to low water on the day of observation; and if on that day the tide does not ebb so much as on a spring tide, the reduction must be increased by the difference in the ebbing of the two tides. Thus if on the day of observation the tide did not ebb so much by two feet as on a spring tide, the reduction corresponding to 8h. ought to be increased two feet, and would therefore be between 6 and 7 feet. Allowance may be made for this by increasing the number of feet marked in fig. 5, by marking 2 feet at A, 3 feet at 1, 4 feet at 2, &c. as is evident.

To reduce a Draught to a smaller Scale.

With a black-lead pencil draw on the draught to be reduced, cross lines, forming exact squares, and on the clean paper for the copy draw the same number of squares, making their sides larger or smaller in proportion to the intended size of the scale, such as $\frac{1}{2}$, $\frac{1}{4}$, &c. the length of the other; distinguish by a stronger mark every fifth or sixth row of squares in both, so that the several corresponding squares may be readily perceived: then, in each of the squares of the draught, draw, by the eye, a curve on the paper, similar to that in the square of the copying draught, till the whole is copied: when the black-lead lines may be rubbed out with bread or india ruber.

A chart may also be reduced in the following manner: thus, suppose you would reduce a chart in the ratio of the line MN (Plate XI. fig. 6) to HI. Draw the line AC, which make equal to HI, upon A as a centre, describe the arch CF, and make the chord CF=MN, join AF; then if you take any distance, AB you wish to reduce, and upon A, as a centre, describe an arch BD; the chord BD, intercepted by the lines AC, AF, will be the reduced distance corresponding to AB. This reduced distance may also be obtained by another method, which is more simple than the former: Take any extent from the large chart, which is to be reduced to a smaller scale, and apply it from A to O (Plate XI. fig. 7): take in your compasses the corresponding distance on the small chart, and with one foot in O sweep an arch P; draw the line AP just touching the arch in P; then if you take any distance from the great chart, and apply it from A to R, and at the point R sweep an arch S to touch the line AP; the extent RS will be the reduced distance corresponding to the line AR.



OF WINDS.

THE earth is surrounded by a fine invisible fluid, called Air, which by its weight is capable of supporting the vapours raised by the sun, and by its elasticity is capable of expanding or spreading itself, so as to fill up a large space. When the elasticity of any portion of the air is changed, by the heat of the sun or by other causes, the neighbouring parts are put in motion to restore the equilibrium; in this manner a current of air is formed, called the *Wind*, which is distinguished by several names, viz. trade winds, monsoons, variable winds, &c. The *trade winds* blow constantly from the same part; the *monsoons* blow half the year one way, and half the other; and the *variable winds* are such as blow without any regularity either as to time, place, or direction. The following observations on the wind have been made by Dr. Halley and others.

There are constant trade winds, blowing from the east, in most parts of the Atlantic and Pacific Oceans, between the latitudes of 30° N. and 30° S.

Near the northern limits of these winds, they blow between the north and east ; and near their southern limits, between the south and east.

In the Atlantic Ocean, at about 100 leagues from the coast of Africa, between the latitudes of 28° and 10° north, there is generally a fresh gale of wind blowing from the N. E.

Those bound to the Caribbee Islands across the Atlantic, find, as they approach the American side, that the N. E. wind becomes easterly, or seldom blows more than a point from the east, either to the northward or southward.

These trade winds on the American side are sometimes extended to 30° , 31° , or even to 32° of north latitude, which is about 4° farther than what they extend to on the African side ; also to the southward of the equator, the trade winds extend 3 or 4 degrees farther towards the south on the coast of Brazil on the American side, than they do towards the Cape of Good Hope, on the African side.

But we must not conclude that the above limits are without exception ; for both their extent and direction vary considerably with the season of the year. When the sun approaches the tropic of cancer the S. E. trade winds prevail farther to the northward of the line, and incline more to the southward of S. E. and the N. E. trade wind inclines more to the eastward ; and the contrary at the opposite season of the year.

On the African coast, from Cape Blanco to Sierra Leone, the winds in general blow from the north, inclining from the westward rather than from the eastward. From Sierra Leone to Cape Palmas, the ordinary course of the winds is from W. N. W. and beyond Cape Palmas, as far as 23° south latitude, from S. W. to S. inclining more to the southward or westward according to the particular situation or bearing of the shores and lands. And the part of the ocean extending along this coast to the distance of 80 or 100 leagues from the shore, is much more troubled with frequent calms, and with sudden and violent gusts of wind, known by the name of Tornadoes, which blow from all parts of the horizon. The reason of this change in the direction of the trade wind near the land is probably owing to the nature of the coast, which being violently heated by the sun, rarefies the air exceedingly, consequently the cool air from the sea will keep rushing in to restore the equilibrium.

In the Gulf of Guinea there is a periodical wind, called *Harmattan*, which blows in a N. E. direction from the interior parts of Africa. The season in which this wind prevails is during the months of December, January, and February.

Between the 4th and 10th degrees of north latitude, and between the longitude of Cape Verd and the easternmost of the Cape Verd Islands, there is a tract of sea, which seems to be condemned to perpetual calms, attended with terrible thunder and lightning, and frequent rains. The cause of this seems to be, that the westerly winds, setting in on the coast of Africa, and meeting the general easterly winds in this tract, balance each other, and so cause the calms ; and the vapours, carried thither by each wind, meeting and condensing, occasion the almost constant rains.

These observations show the reason of the difficulty which ships find in sailing to the southward, between the coasts of Guinea and Brazil, particularly in the months of July and August, notwithstanding the width of the sea is more than 500 leagues. For the S. E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of 4° north latitude, besides coming so much southerly as to be sometimes south, sometimes a point or two to the west ; it then only remains to ply to windward : and if on the one side they steer W. S. W. they get a wind more and more easterly, but then there is danger of falling in with the coast or shoals of Brazil : and if they steer E. S. E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas.

All ships departing from Guinea for Europe, their direct course is northward ; but on this course they cannot go, because the coast, tending nearly

east and west, the land is to the northward ; therefore as the winds on this coast are generally between the south and W. S. W. they are obliged to steer S. S. E. or south, and with these courses they run off the shore ; but in so doing they always find the wind more and more contrary ; so that, though when near the shore they can lie south ; at a great distance they can make no better than S. E. and afterwards E. S. E. with which courses they generally fetch the island of St. Thomas or Cape Lopez, where finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of 4 degrees south, they find the S. E. wind blowing perpetually.

On account of these general winds, all bound from Europe to the West Indies, or to the southern states of America, consider it most advantageous to get as soon as they can to the southward, so they may be certain of a fair and fresh gale, to run before it to the westward. For the same reason, those bound from America to Europe endeavour to gain the latitude of 30 degrees, where they first find the wind begin to be variable, though the most ordinary winds in the North Atlantic Ocean come between the south and west.

And for the same reasons those bound to India from America run to the eastward in the variable winds, so as to be in the longitude of 35° or 38° W. when in the latitude of 30° N. From thence they steer south-easterly towards the Cape de Verds, passing 4° or 5° to the westward of them, unless they wish to stop for supplies, or to correct their longitude. Being then in the common route of the European Indiamen, they steer south-easterly to cross the equator between the longitude of 18° W. and 25° W. where meeting the S. E. trade winds, they must brace up and sail upon a wind till they get through them, and come into the variable winds, where they may steer to the eastward. Near the equator, the trade wind is generally stronger to the westward than to the eastward ; and were it not for the fear of falling in with the Brazil coast, a ship might cross the line farther to the westward than what we have recommended above. Ships homeward bound, from the Cape of Good Hope towards America, may deviate a little to the westward of their straight course, and cross the equator in about 30° W. longitude, in order to take advantage of this fresher trade wind.

Between the southern latitudes of 10° and 30° in the Indian Ocean, the general trade wind about S. E. is found to blow all the year round, in the same manner as in the like latitudes in the south Atlantic Ocean ; and during the six months, from May to November, these winds reach to within 2 degrees of the equator ; but during the other six months, from November to May, a N. W. wind, called *the little monsoon*, blows in the tract lying between the 3d and 10th degrees of south latitude, in the meridian of the north end of Madagascar, and between the 2d and 12th degrees of south latitude, near the longitude of Sumatra and Java.

In the tract between Sumatra and the African coast, and from 3° of south latitude, quite northward to the Asiatic coast, including the Arabian Sea and the Bay of Bengal, the monsoons blow from October to April on the N. E. and from April to October on the S. W. In the former half year, the wind is more steady and gentle, and the weather clearer than in the latter six months. In the Red Sea the winds blow nearly nine months of the year from the southward, that is, from August to May, and the rest of the year from the N. and N. N. W. with land and sea breezes. In the Gulf of Persia the N. W. wind blows from October to July, and about three months from the opposite quarter. These winds being often interrupted by gales from the S. W. and by land breezes.

Between the island of Madagascar and the coast of Africa, and thence northward as far as the equator, there is a tract, wherein, from April to October, there is generally a S. S. W. wind, and a contrary wind the rest of the year, with regular land and sea breezes on both coasts.

To the eastward of Sumatra and Malacca, on the north of the equator,

and along the coasts of Cambodia and China, quite through the Philippines as far as Japan, the monsoons blow N. E. and S. W. the N. E. setting in about October or November, and the S. W. about May.

Between Sumatra and Java to the west, and New-Guinea to the east, there are regular monsoons. The N. W. monsoon blows from October to April, the S. E. monsoon the rest of the year.

The monsoons do not shift suddenly from one point of the compass to the opposite; in some places, the time of the change is attended with calms, in others by variable winds; and it often happens, on the shore of Coromandel and China, towards the end of the monsoons, that there are most violent storms, called Tuffons, greatly resembling the hurricanes in the West Indies, wherein the wind is so vastly strong, that hardly any thing can resist its force; for this reason it is more dangerous to approach those shores at the time of the breaking up of the monsoon than at any other season of the year.

The *land* and *sea breezes* prevail principally between the tropics. The sea breeze generally sets in about ten in the forenoon, and continues till about five or six in the evening: at seven the land breeze begins, and continues till about eight in the morning. The cause of these winds is this:—during the day the sea is not so much heated by the sun as the land, nor so much cooled at night. Hence, in the day time, the cooler air from the sea will rush towards the land to supply the deficiency occasioned by the greater rarefaction of the air, and hence arises the sea breeze. In like manner, during the night, the air at land, being more cooled than that at sea, will therefore blow from the land towards the sea, and hence occasion a land breeze.

A *whirlwind* is a dangerous phenomenon caused by the adjacent air, rushing in from all parts towards a centre with great rapidity, and destroying every thing it passes over in its progressive motion. A *water spout* and whirlwind arises from the same cause, the latter being formed at land, is composed principally of air, but the former being formed at sea, is composed of water.

It was first observed by Doctor Franklin that the N. E. storms on the coast of the United States of America, frequently begin earlier in the southern states than in the northern. This he accounts for by supposing a great rarefaction of air in or near the gulph of Mexico; the air rising thence has its place supplied by the next more northern, and therefore denser and heavier air; a successive current is thus formed, to which the coast and inland mountains give a N. E. direction.

Experiments have been made by several persons to determine the velocity of the wind, by observing the space passed over by a cloud or any light substance, and by other methods; and it has been found that the velocity of the wind in a violent gale is about 50 or 60 miles per hour.



TIDES.

TIDE is a periodical motion of the water of the sea, by which it ebbs and flows twice a day. The *flow* continues about 6 hours, during which the water gradually rises till it arrives to its greatest height; then it begins to *ebb* or decrease, and continues to do so for about 6 more, till it has fallen to nearly its former level; then the flow begins as before. When the water has attained its greatest height it is said to be *high-water*, and when it is alone falling it is called *low-water*.

The cause of the tides is the unequal attraction of the sun and moon upon different parts of the earth. For they attract the parts of the earth's surface nearest to them, with a greater force than they do its centre: and attract the centre more than they do the opposite surface. To restore this equilibrium the waters take a spheroidal figure, whose longer axis is directed

towards the attracting luminary. If the moon only acted upon the water, the time of high water would be when the moon was upon the meridian, above or below the horizon; or rather at an hour or two after, (because the moon continues to act with considerable force for some time after passing the meridian.) But the moon passes the meridian about 48' later every day; of course, if she only acted on the tides, they would be retarded every day 48', and it would be high water at the same distance from her passing the meridian; and it is upon this principle that the time of high water is calculated in most books of navigation, although the time thus calculated will sometimes differ an hour from the truth, owing to the neglect of the disturbing force of the sun. The effect of the moon upon the tides is greater than that of the sun, notwithstanding the quantity of matter in the latter is vastly greater than in the former: but the sun, being at a much greater distance from the earth than the moon, attracts the different parts of the earth with nearly the same force; whereas the moon, being at a much less distance, attracts the different parts of the earth with very different forces. According to the latest observations, the mean force of the sun for raising the tides is to the mean force of the moon as 1 to $2\frac{1}{2}$. By the combined effect of these two forces, the tides come on sooner when the moon is in her first and third quarters, and later in the second and fourth quarters, than they would do if caused only by the moon's attraction. The mean quantity of this acceleration and retardation is given in Table B, subjoined; the use of which will be explained hereafter.

The tides are greater than common about three days after the new and full moon; these are called *spring-tides*. And the tides are lower than common about three days after the first and last quarters; these are called the *neap-tides*. In the former case the sun and moon conspire to raise the tide in the same place, but in the latter the sun raises the water where the moon depresses it. When the moon is in her *perigee*, or nearest approach to the earth, the tides rise higher than they do, under the same circumstances, at other times; and are lowest when she is in her *apogee*, or farthest distance from the earth. The spring-tides are greatest about the time of the equinoxes, in March and September, and the neap-tides are less. All these things would obtain exactly, were the whole surface of the earth covered with sea; but the interruptions caused by the continents, islands, shoals, &c. entirely alter the state of the tides in many cases. A small inland sea, such as the Mediterranean or Baltic, is little subject to tides; because the action of the sun and moon is always nearly equal at the extremities of such seas. In very high latitudes the tides are inconsiderable.

From the observations of many persons, the times of high-water on the days of new and full moon, in the most noted places of the globe, have been collected. These times are usually put in a table against the names of the places, arranged in alphabetical order as in Table XLVII. of the collection accompanying this work, by means of which the times of high-water may be found by various methods. The most common rule prescribed for this purpose, in books of navigation, is that depending on the golden number and epact, the tide being supposed to be uniformly retarded every day. This method will sometimes differ 2 hours from the truth, for which reason I shall not insert it: but shall proceed to explain the calculation by the subjoined tables A and B, and the Nautical Almanac; by means of which the time of high-water may be obtained to a greater degree of exactness than from our common Almanacs.

RULE.

Find the time of the moon's coming to the meridian at Greenwich on the given day, in page VI. of the Nautical Almanac. Enter Table A, and find the longitude of the given place. in the left hand column. correspond *ing*

to which is a number of minutes to be applied to the time of passing the meridian at Greenwich, by *adding* when in *west* longitude, but *subtracting* when in *east* longitude; the sum or difference will be nearly the time that the moon passes the meridian of the given place. With this time enter Table B, and take out the corresponding correction, which is to be applied to the time of passing the meridian of the place of observation, by adding or subtracting, according to the direction of the table.

To this corrected time add the time of full sea on the full and change days; the sum will be the time of high-water at the given place, reckoning from the noon of the given day. If this sum be greater than 12h. 24m. you must subtract 12h. 24m. from it, and the remainder will be the time of high-water nearly, reckoning from the same noon; or if it exceed 24h. 48m. you must subtract 24h. 48m. from that sum, and the remainder will be the time of high water, reckoning from the same noon nearly.

EXAMPLE I.

Required the time of high water at Charleston, (S. C.) March 17, 1820, in the afternoon, civil account?

By the Nautical Almanac I find that the moon passes the meridian of Greenwich at 2h. 31m.; to this I add 11m. taken from Table A, corresponding to the longitude of Charleston. With the sum 2h. 42m. I enter Table B, and find (by taking proportional parts) that the correction is 45m. which is to be subtracted from 2h. 42m. (because immediately over it in the table it is marked Sub.); to the remainder 1h. 57m. I add the time of high water on the full and change days 7h. 15m. (which is found in the tide table following;) the sum 9h. 12m. is the time of high water on the afternoon of March 17, 1820, civil account.

EXAMPLE II.

Required the time of high water at Portland, (Maine) May 23, 1820, in the afternoon, civil account?

By the Nautical Almanac the moon will pass the meridian of Greenwich at 8 hours 49 minutes. The correction from Table A, corresponding to 70° the longitude of Portland is 9m. which added to 8h. 49m. gives the time of the moon's southing at Portland 8h. 58m. nearly. The number in Table B corresponding to 8h. 58m. is 23m. which is to be added to 8h. 58m. (because immediately over it, in the table, is marked Add.) To the sum 9h. 21m. I add the time of high water, on the full and change days, 10h. 45m. and the sum is 20h. 6m. consequently the high water is at 20h. 6m. past noon of May 23, that is, at 8h. 6m. A. M. of May 24. And by subtracting 12h. 24m. from 20h. 6m. we have 7h. 42m. which will be nearly the time of high water on the afternoon of May 23, 1820.

In this manner we may obtain the time of high water at any place, to a considerable degree of accuracy. But the tides are so much influenced by the winds, freshets, &c. that the calculated times will sometimes differ a little from the truth.

Many pilots reckon the time of high water by the point of the compass the moon is upon at that time, allowing 45 minutes for each point. Thus on the full and change days, if it is high water at noon, they say a north and south moon makes full sea; and if at 11h. 15m. they say a S. by E. or N. by W. moon makes full sea; and in like manner for any other time. But it is a very inaccurate way of finding the time of full sea by the bearing of the moon, except in places where it is high water about noon on the full and change days.

When you have not a Nautical Almanac, you may find the time of high water by means of the following tables C and D; and although the former method is the most accurate, yet the latter may be useful in many cases. To calculate the time of full sea by this method, observe the following rule.

RULE.

Enter Table C, and take out the number which stands opposite to the year, and under the month for which the tide is to be calculated; this number, added to the day of the month, will give the moon's age, rejecting 30 when the sum exceeds that number. Against her age found in the left hand column of Table D, is a number of hours and minutes in the adjoined column, which being added to the time of high water at the given place on the full and change days, will give the time of high water required, observing to reject 12h. 24m. or 24h. 48m. when the sum exceeds either of those times.

By this rule I shall work the two preceding examples.

EXAMPLE III.

Required the time of high water at Charleston, (S. C.) March 17, 1820, in the afternoon, civil account?

In the table C, opposite 1820, and under March, stand 16, which, added to the day of the month 17, gives 33, and by subtracting 30, leaves 3, the moon's age: opposite 3 in Table D, is 1h. 46m. which added to 7h. 15m. the time of high water on the full and change days, gives 9h. 1m. for the time of high water; differing eleven minutes from the former method.

EXAMPLE IV.

Required the time of high water at Portland, (Mass.) May 23, 1820, in the afternoon, civil account?

In the Table C, opposite 1820, and under May, stand 18, which added to the day of the month 23, gives (by neglecting 30) the moon's age 11; opposite to this, in Table D, is 9h. 19m. which added to 10h. 45m. the time of high water on the full and change days, gives 20h. 4m. from which subtracting 12h. 24m. there remains 7h. 40m. for the time of full sea May 23, 1820: this differs 2 minutes from the former method.

In the third column of Table D is given the time of the moon's coming to the meridian, for every day of her age: thus, opposite 11 days stand 8h. 57m. which is the time of her coming to the meridian on that day. This table may be of some use when a Nautical Almanac cannot be procured but being calculated upon the supposition that the moon moves uniformly in the equator, the table cannot be very accurate. The numbers in this Table are reckoned from noon to noon; thus, 1h. A. M. is denoted by 13h. 2h. A. M. by 14h. &c.

The time of new moon is easily found, by subtracting the number taken from Table C from 30. Ex. Suppose it was required to find the time of new moon for May, 1820? By examining the table, we find the number corresponding to that time is 18; this subtracted from 30 leaves 12; therefore it will be new moon the 12th May, 1820.

When the time of high water is known for any day of the moon's age we may from thence find the time of high water on the full and change day: by the following

RULE.

Find the time of the moon's coming to the meridian of Greenwich, page VI. of the Nautical Almanac; to this time apply the corrections taken from the tables A and B, (in the same manner as directed in the preceding rule for finding the time of high water) subtract this corrected time from the observed time of high water, and the remainder will be the time of high water, on the change and full days.

NOTE. If the time to be subtracted be greater than the observed time of full sea, you must increase the latter by 12h. 24m. or by 24h. 48m. nearly

EXAMPLE.

Suppose that on the 17th March, 1820, the time of high water at Charle-

ton, (S. C.) was found to be at 9h. 12m. P. M. required the time of high water on the full and change days?

I find, as in example 1st. preceding, that the number to be subtracted is 1h. 57m.—taking this from 9h. 12m. leaves 7h. 15m. which is the time of high water on the full and change days.

When you have not a Nautical Almanac, you may find the time of high water on the full and change by means of the Tables C and D. For in the present example, I find by Table C, that the moon's age was 3, corresponding to which, in the second column of Table D, is 1h. 46m. this subtracted from 9h. 7m. leaves 7h. 21m. for the time of high water on the full and change days.

TAB. A.

TAB. B.

TAB. C.

TAB. D.

				A TABLE FOR FINDING THE MOON'S AGE.												Moon's Age. Day	High Water.		Moon's passage over the meridian.	
Longitude of the place.	Cor. of Moon's passing the me- ridian.	Time of Moon's passing the me- ridian.	Corr.	Add the number taken from this Ta- ble to the day of the month, the sum (rejecting 30 or 60 if necessary) will be the Moon's age nearly.													H.	M.	H.	M.
Deg.	M.	Hours	H. M.	Year	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.				
0	0		Sub.														0	0	0	0
10	1	00	00														1	0	35	0 49
20	2	10	17														2	1	10	1 38
30	3	20	34														3	1	46	2 28
40	4	30	50														4	2	22	3 15
50	5	41	5	1820	15	17	10	18	13	20	30	21	23	29	25	23	5	3	1	4 4
60	6	51	8														6	3	44	4 53
70	7	61	8	1821	20	28	25	20	23	1	2	3	1	5	0	6	7	4	39	6 30
80	8	70	35														8	5	37	7 19
90	9	80	2	1822	7	9	7	9	10	11	12	11	15	16	17	17	9	6	57	8 57
100	10	90	23														10	8	15	9 8
110	11	100	24	1823	18	30	18	13	20	22	22	24	26	26	28	28	11	9	19	10 34
120	12	110	14														12	10	10	11 23
130		120	0	1824	29	1	0	1	2	4	4	6	8	8	10	10	13	11	33	12 12
140																	14	12	8	13 1
150			Sub.	1825	12	13	11	12	13	14	15	16	18	19	19	21	16	12	44	13 50
160		130	17														17	13	19	14 33
170		140	34	1826	22	24	23	23	24	25	25	27	29	29	1	2	18	13	54	15 27
180		150	50														19	14	31	16 16
190		161	3	1827	3	5	3	05	5	6	7	8	10	10	12	12	20	15	11	17 5
200		171	8														21	15	58	17 54
210		181	8	1828	14	15	15	16	17	18	19	19	21	22	23	24	22	16	49	18 42
220		190	33														23	17	57	19 31
230		200	2	1829	25	26	25	27	28	29	0	1	2	3	4	5	24	18	17	20 20
240		210	23														25	19	17	21 9
250		220	23	1830	6	8	6	8	9	10	11	12	13	14	15	16	26	20	32	21 53
260		230	24														27	21	33	22 46
270		240	14	1831	17	18	17	18	19	20	21	23	24	25	26	27	28	22	42	23 35
280		250	0														29	23	42	24 0
290		260	0	1832	28	29	26	0	1	3	3	5	7	7	8	9	30	24	0	24 0

In all the preceding calculations of the time of high water, we have neglected the correction arising from the variation of the distances of the sun and moon from the earth, and from the different declinations of those objects. These causes might produce a correction of 10' or 12' in the time of high water, but in general will be much less, and may therefore be neglected.

CURRENTS.

A **CURRENT** is a progressive motion of the water, causing all floating bodies to move that way towards which the stream is directed. The *set of a current*, is that point of the compass towards which the waters run, and its *drift* is the rate it runs per hour. The most usual way of discovering the set and drift of an unknown current, is thus :

Let three or four men take a boat a little way from the ship : and by a rope fastened to the boat's stern, let down a heavy iron pot or loaded kettle to the depth of 80 or 100 fathoms ; then heave the log, and the number of knots run out in half a minute will be the miles the current sets per hour, and the bearing of the log will show the set of it.

There is a very remarkable current, called the **GULF STREAM**, which sets in a north-east direction along the coast of America, from Cape Florida towards the Isle of Sables, at unequal distances from the land, being about 75 miles from the shore of the southern states, but more distant from the shore of the northern states ; the width of the stream is about 40 or 50 miles, widening towards the north ; the velocity is various from one to three knots per hour, or more, being greatest in the channel between Florida and the Bahamas, and gradually decreasing in passing to the northward ; but is greatly influenced by the winds both in drift and set.

We are chiefly indebted to Doctor Franklin, Commodore Truxton, and Mr. Jonathan Williams, for the knowledge we possess of the direction and velocity of this stream ; its general course, as given by them, is marked on the chart affixed to this work. They all concur in recommending the use of the thermometer, as the best means of discovering when in, or near the stream. For, it appears by their observations, that the water is warmer than the air when in the stream ; and that at leaving it, and approaching towards the land, the water will be found six or eight degrees colder than in the stream, and six or eight degrees colder still, when on soundings. Vessels coming from Europe to America, by the northern passage, should keep a little to the northward of the stream, where they may probably be assisted by a counter current, as is observed by Commodore Truxton. When bound from America to Europe, a ship may generally shorten her passage by keeping in the gulf. By steering N. W. you will generally cross the gulf in the shortest time, as the direction of the stream is nearly N. E. Those who wish for further information on this subject, may consult an ingenious treatise on "Thermometrical Navigation," published by Mr. Jonathan Williams, at Philadelphia, in 1799, and re-published by Edm. M. Blunt, to accompany his Chart of the Western Ocean, in 1819.

In the other parts of the Atlantic ocean the currents are variable, but are generally south-easterly, along the coast of Spain, Portugal and Africa, from the Bay of Biscay towards Madeira and the Cape de Verds. Between the tropics there is generally a current setting to the westward.

There is also a remarkable current which sets through the Mozambique channel, between the Island of Madagascar and the main continent of Africa in a south-westerly direction : in proceeding towards Cape Lagullas the current takes a more westerly course, and then tends round the Cape towards St. Helena. Ships bound to the westward from India, may generally shorten their passage, by taking advantage of this current. On the contrary, when bound to the eastward, round the Cape of Good Hope, they ought to keep far to the southward of it. However, there appears to be a great difference in the velocity of this current at different times ; for some ships have been off this Cape several days endeavouring to get to the westward, and have found no current ; others have experienced it setting constantly to the westward during their passage from the Cape towards St. Helena, Ascension and the West-India Islands.

CURRENTS.

219

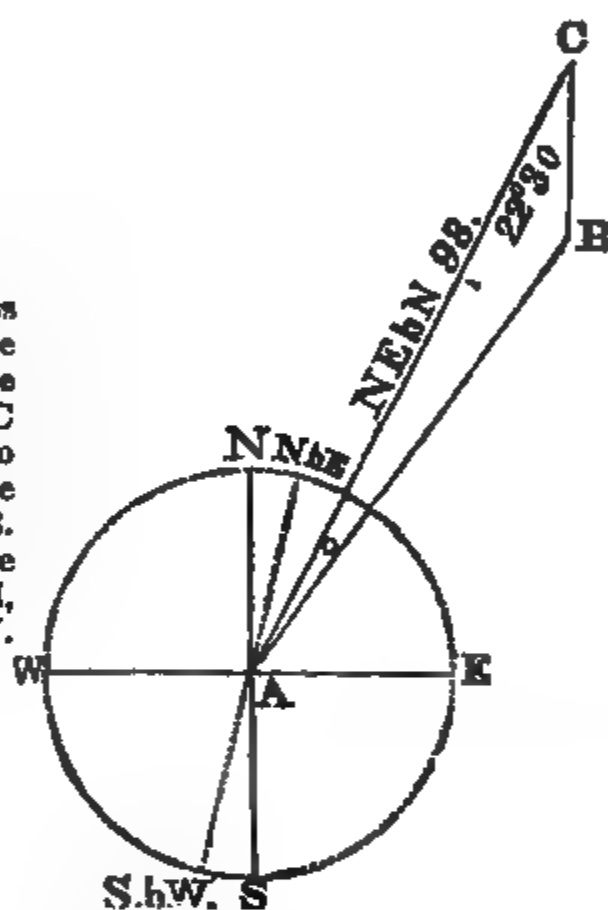
All cases of sailing in a current are calculated upon the principle, that the ship is affected by it in the same manner as if she had sailed in still water, with an additional course and distance exactly equal its set and drift: on this principle the projection and calculation of any problem of this kind may be easily made.

EXAMPLE.

If a ship sails 98 miles N. E. by N. in a current which sets S. by W. 27 miles in the same time; required her true course and distance?

BY PROJECTION.

Describe the compass NESW, through the centre A draw the N. E. by N. line AC=98 miles, through C draw the line CB parallel to the S. by W. line, and make CB=27 miles, and join AB. Then AB will be the course and distance made good, which by measuring are N. E. $\frac{1}{4}$ N. 74 miles.



BY CALCULATION.

The shortest method of calculating this problem is by means of Table I. as in the adjoined Traverse Table; putting in it the course sailed by the ship, and the set of the current, and finding the difference of latitude and departure by that Table, then find the course and distance made good, as in Case VI. Plane Sailing. In the present example the course is N. E. $\frac{1}{4}$ N. and the distance 74 miles nearly.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
N. E. by N.	98	81.5		54.4	
S. by W.	27		26.5		5.3
		81.5	26.5	54.4	5.3
		26.5		5.3	
Diff. Lat.		55.0	Dep. 49.1		

METHOD OF KEEPING

A SHIP'S RECKONING OR JOURNAL AT SEA.

A SHIP'S RECKONING is that account, by which it can be known at any time where the ship is, and on what course or courses she must steer to gain her port. *DRIFT RECKONING* is that account deduced from the ship's run from the last observation.

THE LOG-BOARD.

The daily occurrences on board a ship are marked on a board or slate, called the *log-board* or *log-slate*, kept in the steerage for that purpose, being usually divided into seven columns; the first contains the hours from noon to noon, being marked by some for every two hours, but by others for every single hour; in the second and third columns are the knots and fathoms

1.	K.		Courses.	Winds.	Lee-way	Transactions.
2	6		S. W.	N. E.		
4	5	5		N.W.by W.		
6	3					
8	5					
10	4	5	E. N. E.	N. W.		Moderate gales & fair weather; at 8 A. M. saw a ship to the northward.
12	4					
2	4					
4	1					
6	1					
8			S. W.	W. N. W.	1	
10	4	5				No observation.
12	4					

the ship is found to run per hour, set against the hours when the log was hove. Some navigators do not divide the knot into ten fathoms, but into half knots only, marking the third column H. K. The fourth column contains the courses steered by compass; the fifth, the winds; the sixth, the lee-way,* and the seventh, the alteration of the sails, the business done aboard, and what other remarks the officer of the watch thinks proper to insert. For it should be observed, that it is usual to divide a ship's company into two parts, called the starboard and larboard watches, who do the duty of the ship for four hours and four hours, alternately, except from 4 to 8 P. M. which is divided into two watches. The remarks made on the log-board are daily copied into a book called the *log-book*, which is ruled like the log-board. This book contains an authentic record of the ship's transactions, and the persons who keep a reckoning, transcribe them into their *journals*, and from thence make the necessary deductions relative to the ship's place, every day at noon, which operation is called working a *day's work*. While a ship is in port, the remarks entered in the log-book are called *harbour work* or *harbour journals*, and the day is then estimated according to the civil computation as on shore, that is from mid-night to mid-night; but at sea the day's work ending at noon is dated the same as the civil day, so that the day's work marked Monday began on Sunday noon, and ended on Monday at noon; the day thus marked is called a *nautical day*; the first 12 hours being marked P. M. the latter A. M. There are various ways of keeping journals at sea, according to the different tastes of navigators. Some keep only an abstract of each day's transactions, specifying the weather, what ships or lands were seen, accidents on board, the latitude, longitude, courses, and run: these particulars being drawn from the ship's log-book. Others keep a full copy of the log-book, and the deductions drawn therefrom, arranged in proper columns:—this is the most satisfactory method to those who may have occasion to inspect the journal; and we have adopted it in the following, but shall give an abstract at the end conformable to the other method.

When a ship is about losing sight of the land, the bearing of some notable place (whose latitude and longitude are known) must be observed, and its distance estimated and marked on the log-book: this is called *taking a departure*. In working this first day's work, the calculation is to be made in the same manner as if the ship had sailed that distance from that place upon a course opposite to that bearing, and that course and distance are to be entered accordingly into the traverse table, after allowing for the variation.

To allow for the Variation.

We have already taught the methods of finding the variation, which must be allowed on all courses steered, and on all bearings taken with the compass; to the right hand, if the variation be east; but to the left hand, if west: the observer being supposed to be placed in the centre of the compass, looking towards the point from which the variation is to be allowed.

* The cause of the lee-way and manner of allowing for it, are explained in the following pages.

EXAMPLES.

Courte by compass	Points.	Variation	True course
N. E. by E.	2 W.		N. E. by N.
N. E.	1½ E.		N. E. by E. ¼ E.
N. W.	3 W.		W. by N.
S. E.	3 E.		S. by E.
S. S. W.	1½ W.		S. ½ W.
E. S. E.	1½ W.		E. ¾ S.
S. W. ¼ W.	¼ W.		S. W. ¼ S.
N. N. E. ¾ E.	1½ E.		N. E. ¼ E.

To find the lee-way and allow for it.

The courses must likewise be corrected for lee-way, the nature of which may be thus explained. When a ship sails upon a wind, in a fresh gale, that part of the wind which acts upon the hull and rigging, together with a considerable part of the force exerted on the sails, tend to drive her immediately from the direction of the wind, or, as it is termed, to leeward. But since the bow of a ship exposes less surface to the water than the side, the resistance will be less in the first case than in the second; the velocity therefore in the direction of her head will, in most cases, be greater than the velocity in the direction of her side, and the ship's course will be between the two directions, and the angle contained between the course towards which the ship's head is directed, and the course she really describes through the water, is termed her *lee-way*. The quantity of lee-way to be allowed will depend upon a variety of circumstances; as the mould and trim of the ship; the quantity of sail she carries; her velocity through the water, &c. hence no general rules can be laid down with accuracy that will determine the quantity of lee-way in all cases. The following have, however, been usually given by most writers on navigation.

1. When a ship is close hauled with all her sails set, the water smooth, and a light breeze of wind, she is then supposed to make little or no lee-way.

2. When the top-gallant sails are handed, allow 1 point.

3. When under close reefed topsails, allow 2 points.

4. When one topsail is handed, allow 2½ points.

5. When both topsails are handed, allow 3½ points.

6. When the fore course is handed, allow 4 points.

7. When under the mainsail only, allow 5 points.

8. When under a balanced mizen, allow 6 points.

9. When under bare poles, allow 7 points.

As these allowances depend entirely on the quantity of sail set, without regard to any other circumstance, it is evident that they can be considered only as probable conjectures, and may indeed serve to work up the day's work of a journal that has been neglected. But since the computation of a ship's way depends much upon the accuracy of this allowance, it would be proper for the officer of the watch to mark the lee-way on the log-board, in the column reserved for that purpose. The lee-way may be estimated by observing the angle which the wake of the ship makes with the point right astern, by means of a semi-circle marked on the taffrail, and divided into points and quarters; by means of which the angle contained between the direction of the wake and the point of the compass directly astern, may be easily ascertained.

The lee-way thus determined is to be allowed on all courses *steered, to the right hand of the course steered, when the larboard tacks are aboard,* but on the left hand, when the starboard tacks are aboard*; the person making the allowance being supposed to be looking towards the point of the compass the ship is sailing upon.

EXAMPLES.

Courses steered.	Wind.	Lee-way.	True course.
N. W.	N. N. E.	1 point.	N. W. by W.
E. N. E.	North.	2	East.
E. S. E.	South.	1	E. by S.
W. by N.	N. by W.	¼	W. ¼ N.
E. N. E. ¼ E.	S. E.	3	N. E. ¼ N.

* See the note page 148.

When the variation and lee-way are both to be allowed on a course, you may do it at once, by allowing their sum when they are both the same way, or their difference when the allowance is to be made in different ways, taking care to make the allowance in the same way as the greater quantity ought to be, whether it be the variation or lee-way.

EXAMPLE I.

A ship steers W. by N. with her larboard tacks aboard, and makes one point lee-way, there being two points westerly variation; required the true course?

Lee-way to the right hand 1 point
Variation to the left 2 points

Difference allowed to the left 1 point
Whence the course is west.

EXAMPLE II.

A ship steers E. S. E. with her starboard tacks aboard, and makes two points lee-way, there being one point westerly variation; required the true course?

Lee-way to the left 2 points
Variation to the left 1 point

Sum allowed to the left 3 points
Whence the course is E. by N.

In a violent gale, with a head wind and heavy sea, when it would be dangerous to carry sail, it is usual to lie to under sufficient sail to prevent the vessel from rolling so much as to endanger the masts and rigging. When a ship is lying-to, the tiller is put over to leeward, and when the ship has head-way, the rudder acts upon her to bring her to the wind; the ship then loses her way in the water, which ceasing to act on the rudder, her head falls off from the wind, and the sail which is set fills and gives her fresh way through the water, which acting on the rudder, brings her head again to the wind. Thus the ship is kept continually falling off and coming to. In this case, you must observe the points on which she comes up and falls off, and take the middle between the two points for the apparent course, from which allow the variation and lee-way, and you will obtain the true course.

EXAMPLE.

A ship lying-to under her mainsail, with her starboard tacks aboard, comes up E. by S. and falls off N. E. by E. there being one point westerly variation, and she makes 5 points lee-way—what course does she make good?

The middle between E. by S. and N. E. by E. is E. by N.; and by allowing 6 points to the left hand (viz. 5 for lee-way and 1 for variation) the true course will be obtained N. by E.

To exercise the learner we shall add the examples of correcting for variation and lee-way contained in the following Table.

THE TABLE.

If the ship has been acted upon by a current or a heave of the sea, you must allow the set and drift as a course and distance in the Traverse Table, as directed in p. 219.

Having corrected the courses for lee-way and variation, and estimated the distances sailed, the latitude and longitude in at noon are to be found by either of the preceding methods of sailing. The latitude and longitude, thus calculated, are called the latitude and longitude by dead reckoning, and if the real course and distance made good by the ship could be estimated accurately by the compass and log, nothing more would be necessary to determine the ship's place at any time; but by

Courses steered.	Winds.	Lee-way points	Variation points	Courses corrected.
N. W. $\frac{1}{2}$ W.	N. N. E.	$\frac{1}{2}$	$\frac{1}{2}$ W.	N. $\frac{1}{2}$ W.
W.	N. N. W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. $\frac{1}{2}$ W.
W. S. W.	S.	1	$\frac{1}{2}$ W.	S. $\frac{1}{2}$ W.
W.	S. S. W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	W.
W. by N.	N. by W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. 7 W.
S. W.	W. N. W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. $\frac{1}{2}$ W.
S.	W. S. W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. S. E.
S. S. W.	W.	1	$\frac{1}{2}$ W.	S. $\frac{1}{2}$ E.
S. W.	N. W. by W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. N. W. $\frac{1}{2}$ W.
W.	S. S. W.	$\frac{1}{2}$	$\frac{1}{2}$ W.	W. $\frac{1}{2}$ N.
W. by N.	N. by W.	1	$\frac{1}{2}$ W.	W. S. W. $\frac{1}{2}$ W.
S.	E. S. E.	2	$\frac{1}{2}$ W.	S. $\frac{1}{2}$ W.
E. by S.	S. $\frac{1}{2}$ E.	$\frac{1}{2}$	$\frac{1}{2}$ W.	E. by N.
E. N. E.	N.	$\frac{1}{2}$	$\frac{1}{2}$ W.	E. N. E. $\frac{1}{2}$ E.
E.	N.	$\frac{1}{2}$	$\frac{1}{2}$ W.	E. $\frac{1}{2}$ N.
E.	S.	0	$\frac{1}{2}$ W.	E. N. E. $\frac{1}{2}$ E.
S.	E. S. E.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. by E. $\frac{1}{2}$ E.
E. S. E.	N. E.	$\frac{1}{2}$	$\frac{1}{2}$ W.	E. $\frac{1}{2}$ S.
W. S. W.	S.	$\frac{1}{2}$	$\frac{1}{2}$ W.	S. W. by W.
W. by N.	S. W. by S.	1	$\frac{1}{2}$ W.	W. $\frac{1}{2}$ N.
N. W.	W. S. W.	1	$\frac{1}{2}$ W.	N. W. $\frac{1}{2}$ W.
S.	W. S. W.	1	$\frac{1}{2}$ E.	S. $\frac{1}{2}$ E.
N. by E.	N. W. by W.	$\frac{1}{2}$	1 E.	N. N. E. $\frac{1}{2}$ E.
N. W. by N.	W. by S.	$\frac{1}{2}$	1 E.	N. $\frac{1}{2}$ W.
N. W. by W.	N. by E.	$\frac{1}{2}$	$\frac{1}{2}$ E.	N. W. by W. $\frac{1}{2}$ W.
W. by S.	N. W. by N.	$\frac{1}{2}$	$\frac{1}{2}$ E.	W. $\frac{1}{2}$ S.

reason of the various accidents that attend a ship's way, such as heave of the sea, unknown currents, different rates of sailing between the times of heaving the log, sudden squalls, improper allowance for lee-way and variation, the latitude and longitude of the ship as deduced from the reckoning, will frequently differ from the latitude and longitude by observation. In this case it will be proper to re-examine the calculation to see whether a just allowance has been made for lee-way, variation, bad steerage, drift of the sea, error of the log-line and glass, &c. since it will sometimes be found that a different and more probable estimate of some of these quantities will make the dead-reckoning agree more nearly with the observations. Before the method of finding the longitude by lunar observations was introduced, the mariner had no other observation to be depended on except his latitude, and it was then usual to make allowances for supposed errors in the courses and distances, so as to make the latitude by observation and dead-reckoning agree. The method made use of by Robertson, Moore, and others, was divided into three cases, viz.

CASE I.

When the course was within three points of the meridian, the error was supposed to be wholly in the distance, on the principle that it would require a greater error in the course to cause the given error in the difference of latitude than could be supposed probable to have been committed. In this case the corrected departure, &c. were found, with the course, by dead-reckoning, and the difference of latitude by observation, as in Case IV. of Middle Latitude or Mercator's Sailing.

CASE II.

When the course was between three and five points of the meridian, the error was supposed to be part on the course and part on the distance. In this case, the *corrected* departure was taken equal to the mean of the departure by dead-reckoning, and the departure which corresponds to the distance by dead-reckoning, and the difference of latitude by observation. With the *corrected* departure, and the difference of latitude by observation, the course, &c. were found as in Case II. of Middle Latitude or Mercator's Sailing.

CASE III.

When the course was more than five points from the meridian, the error was supposed to be wholly on the course, on the principle that it would require a greater variation in the distance to make the dead-reckoning and observation agree, than could be supposed probable, whereas it could require but a small change in the course to produce the sought effect. In this case, the corrected departure, &c. were found, with the distance, by dead reckoning, and the difference of latitude by observation, by Case V. of Middle Latitude or Mercator's Sailing.

This method was given in the former editions of this work, in conformity to custom, though I was decidedly opposed to making such corrections, being convinced that the difference between the dead-reckoning and observation is more owing to unknown currents than to errors in the courses and distances given by the log. Even admitting the principle that an arbitrary correction of this kind is proper, the preceding method does by no means appear to be the most probable. To show this, let us take the following example.

Suppose the course by dead-reckoning to be $33^{\circ} 44' 59''$, the distance by the log. 100 miles, and the difference of latitude by observation 73.1 miles. This comes under Case I. and the error must be placed wholly on the distance, which is to be found with the course $33^{\circ} 44' 59''$ (or 3 points nearly) and the difference of latitude 73.1, so that the corrected quantities are nearly by Table I. course $33^{\circ} 44' 59''$, distance 88, and departure 48.8. Now by altering the course two seconds, making it $33^{\circ} 45' 1''$, still retaining the distance by dead reckoning 100 miles, and the difference of latitude by observation 73.1, the example will come under Case II. and the corrected depar-

ture is the mean of the departure by dead-reckoning 55.6, and that corresponding to the distance 100, and the difference of latitude by observation 73.1; namely 68.2, so that this *corrected* departure is 61.9 miles, with which and the difference of latitude by observation 73.1, we obtain the corrected course $40^{\circ} 15'$ and the distance 96. Thus we see that by altering the course by dead reckoning *only two seconds*, the corrected course varies from $33^{\circ} 44' 59''$ to $40^{\circ} 15'$ or above 6 degrees, and the departure varies from 48.0 to 61.9, both of which are highly improbable. This defect of the rule evidently arises from the sudden change of the method when the course is near 3 or 5 points; it being much more probable that the variations take place by small degrees, in such manner that when the course by dead-reckoning is exactly on the meridian, the error ought to be in the distance, and when the course is 8 points from the meridian, the error ought to be in the course, and at intermediate courses the errors in distance ought to be greater, the nearer the course is to the meridian, and the errors in the course greater, the farther it is from the meridian. Both these objects are attained in a very simple manner in the method proposed by the ingenious mathematician, Dr. Adrian, late Professor of Mathematics and Natural Philosophy in Columbia College, New-York, which is somewhat similar to my method of correcting a survey. *His method consists in finding, with the difference of latitude by observation, and the departure by account, the corrected course, distance, and difference of longitude by Case II. of Middle Latitude or Mercator's Sailing*, so that no correction whatever is made in the departure. The propriety of this method will appear evident by observing that a change in the departure can have no tendency whatever in correcting an error in the latitude, and there can be no reason given why such change should be made to the eastward rather than to the westward, since it is supposed that all the allowances for heave of the sea, falling off the course, variation, error of the log, &c. have been previously taken into the calculation, and it seems to be contrary to sound reasoning to vary any of the elements when it will not serve to correct the known error of the latitude, particularly when there can be no reason given why the change should be made in one direction rather than another. In addition to this, the proposed method is not liable to the inconvenience of a sudden change in the rules when the course is near 3 or 5 points. It has also another advantage with respect to simplicity of calculation arising from the circumstance that the corrected difference of longitude is nearly the same as the difference of longitude by dead-reckoning. For the departure is not varied by the rule, and the middle latitude differs rarely more than a few minutes on account of the difference between the latitude by observation and account, so that in keeping a journal it will not be necessary to make any change in the longitude by dead-reckoning, even if you have not had an observation for several days. To illustrate this method I shall give the following

EXAMPLE.

Yesterday at noon we were in the latitude of $39^{\circ} 18' N.$ and by an observation at noon this day are in the latitude of $37^{\circ} 48' N.$ our dead-reckoning gives 107 miles southing and 64 miles westing. Required the course, distance, and difference of longitude?

With the difference of latitude by observation 90 miles (the difference of $37^{\circ} 48'$ and $39^{\circ} 18'$) and the departure by dead-reckoning 64 miles, I find by Case II. of Mid. Lat. Sailing, the course nearly 35° , and the distance 110 miles; and with the middle latitude by observation $38^{\circ} 33'$, and the departure 64 miles, I find the difference of longitude to be 82 miles. If the middle latitude by dead-reckoning $38^{\circ} 41'$ had been taken, the result would have been nearly the same.

If you have not had an observation several days, and then find an error in the latitude by account, you may on these principles correct the latitude

on the intermediate days, by saying, *as the sum of all the distances sailed, since the first observation, is to the whole error in the latitude, so is the sum of the distances sailed from the time of taking the first observation, to the noon of any particular day, to the correction of the latitude by dead-reckoning on that day, southerly if the last latitude by observation is south of the latitude by dead-reckoning, otherwise northerly.* Thus, if the latitudes by dead-reckoning at noon, on four successive days, were $41^{\circ} 0'$, $41^{\circ} 30'$, $42^{\circ} 0'$, $43^{\circ} 0'$, the latitude by observation on the first day $41^{\circ} 0'$, and on the last day $43^{\circ} 15'$, differing 15 miles from the latitude by account; the distances sailed by the log, on the three days respectively, 30, 90, and 105 miles; we must say, as the whole sum of the distances 225 miles, is to the error of the latitude 15 miles, so is the first distance 30, to the correction of the second latitude $2'$, and so is the sum of 30 and 90 ($=120$) to the correction of the third latitude $8'$, so that the corrected latitudes will be $41^{\circ} 0'$, $41^{\circ} 30' + 2' = 41^{\circ} 32'$, $42^{\circ} 0' + 8' = 42^{\circ} 8'$ and $43^{\circ} 15'$, and the corrected differences of latitude on the successive days will be $32'$, $36'$, and $67'$, with which and the departure by dead-reckoning, the corrected courses, distances, &c. on each day may be found, if thought necessary: but as the corrected longitude is not sensibly altered by any of these corrections, it appears to be in general wholly unnecessary to make any alteration in the Journal on this account. But if it be thought proper to notice these corrections in plotting off the track of a ship, it will be necessary first to plot off the courses by D. R. and then to place the points arrived at, at the end of each day, as much to the north or south of the places by D. R. as will make the latitudes of those points agree with the corrected latitudes found by the above rule.

The latitude and longitude by dead-reckoning being found by the preceding methods; thence may be determined the bearing and distance of the place of destination; but when the mariner is fearful that his longitude by account is inaccurate, and he has no lunar observations to correct it, he must get into the latitude of the place, and (if possible) run east or west according to his situation, and the prevailing state of the winds.

We have now given all the rules necessary for working a day's work and for the convenience of the learner (to enable him to refer to them easily) we have here collected them in the seven following articles.

Rules for working a day's work.

1. Correct the several courses sailed* for variation and lee-way, and enter them in a traverse table, and opposite to each course place the distance run on that course, found by summing up the knots and fathoms sailed by the ship on that course. Find in Table I. or II. the difference of latitude and departure corresponding to each course and distance, and set them in their respective columns: then the difference between the sums of the northings and southings will be the difference of latitude made good, of the same name with the greater: and the difference between the sums of the eastings and westings will be the departure made good, of the same name with the greater quantity.

2. Seek in Table I. or II. until the above difference of latitude and departure are found together in their respective columns; opposite to these will be the distance made good, and at the top or bottom of the page, according as the departure is less or greater than the difference of latitude, will be found the course.

3. If the latitude from which the ship's departure is taken, or yesterday's latitude, be of the same name as the difference of latitude, add them together; but if of different names, take their difference: the sum or remainder will be the present latitude, of the same name as the greater.

4. Find the middle latitude between the latitude of yesterday and this

* The set and drift of a current (if there be any) is to be reckoned as a course and distance, and on the first day after losing sight of the land the bearing and distance of it are to be taken into account.

day. which take as a course in Table II. and seek for the departure in the column of Diff. Lat. then will the distance corresponding, be the difference of longitude, of the same name as the departure.

5. If the longitude in yesterday be of the same name as the difference of longitude, add them together ; but if of different names, take their difference ; the sum or remainder will be the long. in, of the same name as the greater.

6. If a lunar observation were taken at any time of the day, you must find, by the above method, the difference of longitude made since taking the observation for regulating the watch, and thence the longitude in at noon by that observation, and enter it in the Journal as the longitude by observation.

7. Find on a general chart the spot corresponding to the latitude and longitude by observation, and that place will represent the situation of the ship, whence the bearing and distance of the intended port may be found. The same may be obtained by middle latitude sailing, by inspection of Table II. thus: Find the middle latitude between the place of the ship and the proposed place, and seek for that latitude as a course in Table II. and find in the corresponding page of the Table, the difference of longitude (between the ship and the proposed place) in the distance column, opposite to which, in the latitude column, will be the departure. Seek in Table I. for this departure and the difference of latitude (between the ship and the proposed place) till they are found to agree, corresponding thereto will be the bearing and distance required. If the magnetic bearing be required, the variation must be allowed on the true bearing ; to the right hand if the variation is westerly, or to the left hand if easterly.

We shall now proceed to exemplify the above rules ; first by a few examples of separate day's works, and then by a Journal from Boston to Madeira, kept in the usual form.

METHOD OF KEEPING A JOURNAL AT SEA.

227

EXAMPLE I.

Yesterday, at noon, we were in the latitude of $40^{\circ} 21' N.$ and the longitude of $56^{\circ} 28' W.$ and have sailed till this day at noon, as per log-board; required the course and distance made good, with the latitude and longitude in?

LOG-BOARD.								
H.	K.	F.	Courses.	Winds.	L. W.	Remarks.		
2	6		S. W. by W. $\frac{1}{4}$ W.	N.		These 24 hours moderate gales and cloudy weather. At 4 P. M. spoke ship Washington, from New-York, bound to Cork.*		
4	5							
6	5				N. W.			
8	5							
10	3	6	S. W. $\frac{1}{4}$ W.					
12	3	4						
2	3	4						
4	4	5						
6	4	6	S. W. $\frac{1}{4}$ S.	W. N. W.		At 6 A. M. stowed the anchors and unbent the cables and coiled them between decks. Variation 2 $\frac{1}{2}$ points westerly.*		
8	5							
10	4	5						
12	4							

By examining the log-board it appears that the ship goes large and makes no lee-way; therefore by allowing the variation on each of the courses, they will stand as in the adjoined Traverse Table. Then the distances marked on the log-board must be summed up and doubled, because marked only for every two hours.† In allowing for the knots,

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
S. W. $\frac{1}{4}$ S.	45		33.2		27.3
SSW. $\frac{1}{4}$ W.	89		34.4		13.4
S by W $\frac{1}{4}$ W.	27		25.8		7.8
Diff. Lat.		93.4		Dep. 53.5	

you must reckon 10 to a mile; and when the tenths are above 5, you must add one mile to the distance. Having found the distances you must find the corresponding differences of latitude and departures, in Table I. or II. and then with the whole difference of latitude and departure, find the course and distance made good, and the difference of longitude, by Case II. of middle latitude sailing.

In the present example, the difference of latitude is $93' = 1^{\circ} 33' S.$
 Yesterday's latitude $48^{\circ} 21' N.$

The difference is the latitude in $46^{\circ} 48' N.$
 Sum of latitudes $95^{\circ} 9'$
 Middle latitude $47^{\circ} 34'$

With the difference of latitude made good $93.4 S.$ and the departure $53.5 W.$ I enter Table II. and find they correspond nearly to a course of $S. 30^{\circ} W.$ and distance 103 miles. Then with the middle latitude $47^{\circ} 34'$ or 48° , I enter Table II. and find the departure 53.5 in the lat. column, opposite to which, in the distance column, is the diff. of long. $80' = 1^{\circ} 20' W.$

Longitude left $56^{\circ} 28' W.$
 Sum is the longitude in $57^{\circ} 48' W.$

* As these examples were given only to illustrate the rules, we have not been attentive to mark the true variation.

† In India voyages it is customary to mark the log-board every hour; in that case, the distances marked on the log being summed up, will be the true distance sailed.

EXAMPLE II.

Yesterday at noon we were in the latitude of $35^{\circ} 46' N.$ and of $17^{\circ} 42' W.$ and have sailed till this noon as per log-board: latitude and longitude in, and the bearing and distance of Cape S

LOG-BOARD.					
H.	K.	F.	Courses.	Winds.	Remarks.
1	6	6	S. by E. $\frac{1}{4}$ E.	S. W. $\frac{1}{4}$ W.	These 24 hours more and clear weather.
2	6	6			
3	5	8			
4	5	8			
5	5	8			
6	5	8			
7	5	8			
8	5	8			
9	5		S. S. E.	S. W.	At 8 A. M. saw a shipward, steering east.
10	5				
11	5	2			
12	5	2			
1	5	3			
2	5	3			
3	5	5	S. S. E. $\frac{1}{4}$ E.	S. W. by S. $\frac{1}{4}$ W.	
4	5	5			
5	5	5			
6	5	5			
7	5	5			
8	5	5			
9	5	6	S. E. by S.	S. W. by S.	Variation $\frac{1}{4}$ point east
10	5	6			
11	5	4			
12	5	4			

The courses being corrected for lee-way and variation, and the distances summed up (but not doubled since the log-board is marked for every hour) will stand as in the adjoined Traverse Table. Hence the difference of latitude made good is 105.4 S. and the departure 81.7 E. consequently the course is S. 38° E. and the distance 133 miles nearly.

TRAVERSE TABLE			
Courses	Dist	N.	S.
S. S. E. $\frac{1}{4}$ E.	48		41.
N. E. $\frac{1}{4}$ S.	81		24.
S. E. $\frac{1}{4}$ S.	89		24.
S. E. $\frac{1}{4}$ E.	22		14.
Diff. Lat. 105.4			

Latitude left	$35^{\circ} 46' N.$
Diff. of lat.	$1^{\circ} 45' S.$
Latitude in	$34^{\circ} 1' N.$
Sum of lats.	$69^{\circ} 47'$
Middle lat.	$34^{\circ} 53'$

With the middle latitude $34^{\circ} 53'$ and the departure 81.7, the distance found to be 100 miles =
 Longitude left 1°
 Longitude in 11°

To find the bearing and distance of Cape St. Vincent.

Latitude in	$34^{\circ} 1' N.$	Mer. parts	2173	Long. in
C. St. Vincent's lat.	$37^{\circ} 1' N.$	Mer. parts	2394	C. St. Vin. lon.
Diff. of lat.	$3^{\circ} 0' = 180'$	Mer. diff. lat.	221	Diff. long.

BY LOGARITHMS.

To find the bearing.		To find the distance.	
As mer. diff. lat. 221	log. 2.34439	As radius 45'	
Is to radius 45°	10.00000	Is to prop. diff. lat. 180	
So is diff. long. 420	log. 2.62325	So is secant course $62^{\circ} 15'$	
To tang. course $62^{\circ} 15'$	10.27896	To the distance 386.6	
Hence the bearing of Cape St. Vincent is N. $62^{\circ} 15'$ E. and distance 386.6 miles.			

H	K	F.	Courses.	Winds.	LW.	Remarks on board, Friday, March 26, 1822.
1	7		E. by S.	N. by E		Fresh gales and pleasant weather.
2	7					
3	7					Saw a number of fishing vessels to the southward.
4	7					
5	7					
6	7					
7	7		E. by S.	S. N. E.		At noon observed the altitude of the sun's lower limb bearing south
8	7					50° 27' N
9	7					Add for semi-diameter, dip, &c. 0 12
10	7					The refraction being small is neglected
11	7					
12	7					
1	7		E. S. E.			Correct altitude 50 39
2	7					Subtract from 90 00
3	6	8				
4	6	8				☉'s zenith distance 39 21 N
5	6	4				☉'s correct declination 2 22 N
6	6	4				
7	6	4				Latitude by observation 41 43 N
8	6	4				
9	6	6				
10	6	6				
11	6	5				
12	6	5				Variation 1 points westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S 80° 15' E	162	S. 27	E. 160	41° 43'	41° 43'	3° 35'	64° 22'	Funchal 76° 27' E distance 2326 miles

The variation being allowed on each course, and the distances summed up, they will stand as in the adjoining traverse table; from hence, by means of Table I. I find the difference of latitude 27.5, and the departure 160.0, which corresponds to the course S. 80° 15' E. and the distance 162 miles.

Yesterday's latitude 42° 10' N.
Diff. of latitude 27 8

Latitude in 41 43 N.
Sum of latitudes 43 53
Middle latitude 41 58

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. 4 S.	42		2.1	41.9	
E. 3 S.	42		6.2	41.5	
E. S. E. 4 E.	79		19.2	76.8	
		D. Lat. 27.5		160.0 Dep.	

With the middle latitude 41° 58' or 42° as a course, I enter Table II. and seek for the departure 160.0 in the latitude column; the nearest number to which is 159.3 corresponding to the distance 21, which is therefore the difference of longitude, 3° 35' E. equal to

Yesterday's long. 87 37 W.

Long. in

64 22 W.

To find the bearing and distance of Funchal.

Latitude in 41 43 N.	Mer. parts 2759	Longitude in 64° 22' W.
Funchal's lat. 32 38 N.	Mer. parts 2073	Funchal's long. 16 54 W.
Diff. of lat. 9 5	M. D. lat. 686	Diff. of long. 47 28
60		60

In miles 545

In miles 2848

By Case I. of Mercator's sailing, I find the bearing of Funchal to be S. 76° 27' E and its distance 2326 miles.

When the sun was upon the meridian, the altitude of his lower limb was 50° 27', to which add 15' for the semi-diameter, parallax, and the dip of the horizon; the refraction, (given in Table XII) for this altitude being small, is neglected, hence the correct central altitude was 50° 39' which subtracted from 90°, leaves the zenith distance 39° 21' which must be called north, because the sun bore south when on the meridian; then in Table IV. I find the sun's declination at noon at Greenwich 2° 18' N. to this add the correction 4' taken from Table V. corresponding to the ship's longitude; the sum is 2° 22' N. the correct declination; and since the declination and zenith distance are both north, I add them together, and the sum will be the latitude by observation 41° 43' N. which agrees with the latitude by account.

H	K	F	Courses.	Winds.	L W	Remarks on board, Sunday, Mar. 28, 1854.
1	7		S E. by E.	NE by E.	1	Fresh gales with rain.
2	7					At 4 A. M. spoke the ship Franklin, from Philadelphia, bound to Lisbon.
3	8	8				
4	6	8				
5	0					
6	6					
7	5	4				
8	5	4				
9	5	6	S. E.	E. N. E.	1	At noon, observed mer. alt.
10	5	6				sun's L. L. $53^{\circ} 53'$
11	5	6				Add for semi-diameter, &c. $0 12$
12	5	6				
1	5	3				Sun's correct altitude $54 5$
2	5	3				Subtract from $90 00$
3	5	3				
4	5	3				Sun's zenith distance $35 55$ N.
5	6		SE. by S.	E. by N.	1	Sun's correct declination $3 9$ N.
6	6					
7	6					Latitude observed $39 4$ N.
8	6					
9	6					
10	6					
11	5					
12	5					Variation $\frac{1}{2}$ points westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S. $42^{\circ} 29'$ E.	138	S. 102	E. 93	$39^{\circ} 4'$	$39^{\circ} 4'$	$2^{\circ} 2'$	$58^{\circ} 12'$	Funchal S. $79^{\circ} 7'$ E. distance 2045 miles

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
S. E. $\frac{1}{2}$ E.	50		29.1	40.2	
S. E. $\frac{1}{4}$ S.	14		32.6	29.5	
S. S. E. $\frac{1}{2}$ E.	16		39.5	23.6	
		D. Lat. 101.9 93.3 Dep.			

The lee-way and variation being allowed on the courses, they will stand as in the adjoined traverse table. Then with the difference of latitude and departure the course is found to be S. $42^{\circ} 29'$ E. and the distance 138 miles.

Yesterday's latitude	$40^{\circ} 46'$ N.	With the middle lat. $39^{\circ} 55'$ or 40°
Difference of latitude $102' = 1 42$	S.	as a course, and the dep. 93.3, taken
Latitude in	$39 4$ N.	as difference of latitude, the diff. of
Sum of latitudes	$79 50$	long. is found to be 123 miles = $2^{\circ} 2'$ E.
		Yesterday's longitude $60 14$ W.
Middle latitude	$39 55$	Longitude in $58 12$ W.

The course made good each day is marked in the journal to degrees and minutes, as it was calculated by logarithms; but for practical purposes, it sufficiently exact to find it to the nearest degree by means of Table II.

To find the bearing and distance of Funchal.

By Case I. Middle Latitude Sailing.

Latitude in	$39^{\circ} 4'$ N.	Longitude in	$58^{\circ} 12'$
Funchal's latitude	$32 38$ N.	Funchal's longitude	16
Difference of lat.	$6 26 = 386$ miles.	Difference of long.	41
Sum of latitudes	$71 42$		
Middle latitude	$35 51$	In miles	24

With the middle latitude $35^{\circ} 51'$ or 36° as a course, and the difference 2478 as a distance, I calculate the departure; with that and the difference I find the distance and course, by Case I. of Middle Latitude Sailing.

H.	K.	F.	Courses.	Winds.	L. W.	Remarks on board, Tuesday, Mar. 30, 1824.		
1	3		East.	N. N. E.	3	These 24 hours fresh gales and squally. Handed the fore and main courses.		
2	3							
3	3							
4	3							
5			Lay to, up S. E. by E.		5			
6			off S. E. by S. Drift $1\frac{1}{2}$					
7			miles per hour.					
8								
9			Up S. off S. W. Drift		5			
10			$1\frac{1}{2}$ miles per hour.					
11								
12								
1	2	5	E. by N. S. E. by S.		$1\frac{1}{2}$	At midnight more moderate; wore ship and set the courses.		
2	2	5						
3	3							
4	3							
5	3	5				At 6 A. M. set the topsails close reefed.		
6	3	5						
7	2	5						
8	2	5						
9	2	5				Variation 1 point westerly.		
10	2	5						
11	2							
12	2							
Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
N 76° 17' E.	31	N. 7	E. 30	N. 37° 55'		E. 0° 38'	W. 57° 34'	Funchal S. 80° 58' E. distance 2017 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. S. E.	12		4.6	11.1	
South.	6		8.0		
W. S. W.	6		2.3		5.5
N. E. $\frac{1}{2}$ E.	32	20.3		24.7	
		20.3	12.9	35.8	5.5
		12.9		5.5	
D. Lat.	7.4	Dep.	30.8		

Taking the middle points, (viz. S. E. and S. S. W.) between the point to which the ship comes to and falls off, as taught in the rules of lying to, and then allowing as before for the variation and lee-way, the traverse table will stand as adjoined. With the difference of latitude and departure the course is found to be N. 76° 17' E. and the distance 31 miles.

Yesterday's latitude	37° 48' N.	With the middle lat. 37° 51' (or 38°)
Difference of latitude	7 N.	as a course, and the departure 30.8 used
Latitude in	37 55 N.	as difference of latitude, I find the dif-
Sum of latitudes	75 43	ference of longitude to be 0° 38' E.
Middle latitude	37 51	Yesterday's longitude 58 12 W.
		Longitude in 57 34 W.

To find the bearing and distance of Funchal.

Latitude in	37° 55' N.	Longitude in	57° 34' W.
Funchal's latitude	32 38 N.	Funchal's longitude	16 54 W.
Diff. of latitude	5 17 = 317 miles.	Diff. of longitude	40 40
Sum of latitudes	70 33		80
Middle latitude	35 16	In miles	2440

With the middle latitude 35° 16' and the difference of longitude 2440, the departure is found to be 1992; with that and the difference of latitude 317, the bearing of Funchal is found to be S. 80° 58' E. and the distance 2017 miles.

FROM BOSTON TO MADEIRA.

237

H.	K.	F.	Courses.	Winds.	L. W.	Remarks on board, Wednesday, Mar. 31, 1834.
1	5		E. S. E.	South.	1	Pleasant gales and fair weather.
2	5					
3	5					
4	5					
5	5	6				
6	5	6				
7	5	4				
8	5	4				
9	5	5				
10	5	5	E by S $\frac{1}{2}$ S.	S. $\frac{1}{2}$ E.	$\frac{1}{2}$	
11	6					
12	6					
1	7					Variation 1 point westerly per azimuth.
2	7					
3	7					
4	7					
5	7					
6	7					
7	7					
8	7					
9	7					
10	7					
11	8					
12	8					

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
East.	151	0	E.	N.		E.	W.	Funchal S. $80^{\circ} 12'$ E. dist. 1863 miles.
			151	$37^{\circ} 55'$		$3^{\circ} 11'$	$54^{\circ} 23'$	

The variation and lee-way being allowed on both courses, it appears that the ship has made a due east course, the distance sailed 151 miles is the departure, and the difference of longitude is found by Case II. of Parallel Sailing. The latitude in is the same as yesterday's lat. $37^{\circ} 55'$ N. Taking this as a course, and the departure 151 as difference of latitude, the distance which corresponds is the difference of longitude, 191 miles = $3^{\circ} 11'$ E.

Yesterday's longitude $57^{\circ} 34'$ W.

Longitude in $54^{\circ} 23'$ W.

To find the bearing and distance of Funchal.

Latitude in	$37^{\circ} 55'$ N.	Longitude in	$54^{\circ} 23'$ W.
Funchal's lat.	$32^{\circ} 38'$ N.	Funchal's long.	$16^{\circ} 54'$ W.
Diff. of latitude	$5^{\circ} 17' = 317$ miles.	Diff. of long.	$37^{\circ} 29'$ W.
Sum of latitudes	$70^{\circ} 33'$		60
Middle latitude	$35^{\circ} 16'$	In miles	2249

Hence by case I. of Middle Latitude Sailing, the departure is found to be 2336 miles, the bearing of Funchal S. $80^{\circ} 12'$ E. and the distance 1863 miles.

2

ARK.

100

The courses being corrected for
leeway and variation, the traverse ta-
ble will be as here given.

Hence the course is S. $85^{\circ} 24'$ E.
distance 202 miles.

Yesterday's latitude
Diff. of latitude

Lat. in by account

Yesterday's long.
dep. 201.3, the diff. of

Longitude in by account

leaves 9 miles from the latitude by dead re-
- correction on this account.

	$97^{\circ} 55'$ N.
	10 S.
	<hr/>
	37 00 N.
	<hr/>
	54 23 W
	<hr/>
	4 15 E
	<hr/>
	50 21

Hence the course	370 55' N.
distance 202 miles.	10 S.
Yesterday's latitude	<hr/>
Diff. of latitude	37 00 N.
Lat. in by account	<hr/>
Yesterday's long.	54 23 W.
dep. 201.3, the diff. of	4 15 E.
.....	<hr/>
Longitude in by account	50 21
.....	

Longitude in by account 50
9 miles from the latitude by dead re
correction on this account.

FROM BOSTON TO MADEIRA.

239

F.	Courses.	Winds.	L W	Remarks on board, Friday, April 2, 1824.
5	E. S. E.	South.	4	Fresh gales, with rain.
5				
5				
5				
	E. S. E.	S. W.	0	
5				Saw a ship to the southward.
5				This day took a lunar observation, by mea-
5				suring the distance of the moon from the star
5				Pollux, the longitude at noon, deduced from
				this observation, was 45° 50' W.
5				
5				
5				
5				Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long	Long. in.	Bearing & Dist.
56° E	202	S. 35	E. 199	N. 36° 55'		E. 4° 9'	W. 45° 59'	Funchal S. 79° 50' E. dist. 1456 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
S. 42			4.1	41.8	
S. 160			31.2	156.9	
		D. Lat. 35.3		198.7	Dep.

The lee-way and variation being allowed on the courses, the traverse table will be as here given; hence the course was S. 79° 56' E. and the distance 202 miles.

day's latitude	37° 30' N.	With the middle lat. 37° 12' and the
ence of latitude	35	dep. 198.7, the difference of longitude
		is found to be 249 miles = 4° 9' E.
de in	36 55 N.	Yesterday's longitude
of latitudes	74 25	50 8 W.
e latitude	37 12	Longitude in
		45 59 W.

To find the bearing and distance of Funchal.

de in	36° 55' N.	Longitude in	45° 59' W.
al's latitude	32 38 N.	Funchal's longitude	16 54 W.
f latitude	4 17 = 257 m.	Diff. of longitude	29 5
			60
of latitudes	69 33		
e latitude	34 46	In miles	1745

ice by Case I. of Middle Latitude Sailing, the bearing of Funchal is to be S. 79° 50' E. and its distance 1456 miles.

H	K	F.	Courses	Winds.	L. W.	Remarks on board, Saturday, April 8, 1834.
1	9	6	E. S. E.	West.		Fresh gales and rainy weather; latter part clear.
2	9	8				A great swell from the N. E. for which I allow 0 miles.
3	9	4				
4	9	4				
5	9					
6	9					
7	9					
8	9					
9	9	5				Obs. alt. sun's lower limb at noon $58^{\circ} 58'$
10	9	5				Correct. for semi-diam. &c. add $0 12$
11	9	5				
12	9	5				Sun's correct altitude $59 10$
1	9					Subtract from $90 00$
2	9			N. W.		
3	9					Sun's zenith distance $30 50$ N.
4	9					Sun's declination $5 27$ N.
5	9					
6	9					Latitude observed $36 17$ N.
7	9					
8	9					
9	9					
10	9			North.		
11	9					
12	9					Variation $1\frac{1}{2}$ point westerly per azimuth.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
$S 79^{\circ} 22' E.$	217	S. 40	E. 213	$36^{\circ} 15' N.$	$36^{\circ} 17' N.$	$40^{\circ} 25' E.$	$41^{\circ} 34' W.$	Funchal S. $79^{\circ} 50' E.$ dist. 1240 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. $\frac{1}{2}$ S.	220		32.5	217.6	
SSW. $\frac{1}{4}$ W.	9		7.7		4.6
		D. lat	40.0	217.6	4.6
				4.6	
		Dep.	213.0		

In this day's work the swell is considered as a current setting the ship 9 miles per day; and since the swell comes from the N. E. it must set the ship S. W. and allowing the variation S. $W. \frac{1}{4} W.$ 9 miles, these are placed as a course and distance in the traverse table—
 With the difference of latitude and departure the course is found to be S. $79^{\circ} 22' E.$ and the distance 217 miles.

With the middle lat. $36^{\circ} 36'$ and the dep. 213 miles, the diff. of long. is found 265 miles = $4^{\circ} 25' E.$
 Yesterday's long. $45 59 W.$
 Longitude in $41 34 W.$

Yesterday's latitude $36^{\circ} 55' N.$
 Difference of latitude $40 S.$
 Latitude in $36 15 N.$

Latitude in $36^{\circ} 17' N.$
 Funchal's latitude $32 38 N.$
 Difference of latitude $3 39 = 219 m.$
 Sum of Latitudes $68 55$
 Middle latitude $34 27$

To find the bearing and distance of Funchal.

Longitude in $41^{\circ} 34' W.$
 Funchal's longitude $16 54 W.$
 Diff. of Long. $24 40$
 In miles 1480

Hence by Case I. Middle Latitude Sailing, the bearing of Funchal is found to be S. $79^{\circ} 50' E.$ and its distance 1240 miles.

To find the bearing and distance of Funchal by Mercator's Chart.

Having pricked off the place of the ship at noon, lay a ruler from that point to Funchal; take the nearest distance between the centre of the compass and the ruler, then slide one foot of the compass along the edge of the ruler, keeping the other foot at the greatest distance from it, and it will be found to run nearly upon the E. by S. line, which is therefore the bearing of Funchal then take in your compass the extent from the place of the ship to Funchal, and apply it to the graduated meridian, making one foot as much above one place as the other is below the other place, and the extent will be found to measure $20\frac{1}{2}$ degrees, or 1230 miles, which was the distance of the ship from Funchal nearly.

FROM BOSTON TO MADEIRA.

241

H.K.	F.	Courses	Winds	L.W.	Remarks on board, Sunday, April 4, 1824.	
1	7	4	E. S. E.	N. E.	1	First part fresh gales; latter part more moderate, a heavy sea running.
2	7	4				
3	6	6				
4	6	6				
5	6					
6	6					
7	5	4	S. E.	E. N. E.	1	Mer. alt. sun's lower limb 81° 3'
8	5	4				Correction for semi-diameter, &c. 0 12
9	4	6				Sun's correct altitude 61 15
10	4	6				Subtract from 90 00
11	4		S. S. E.	East.	1	Sun's zenith distance 28 45 N.
12	4					Sun's declination 5 50 N.
1	4		S. by E.	E. by S.	1½	Latitude observed 34 35 N.
2	4					
3	4					
4	4					
5	4	5	S. by E.		1½	
6	4	5				
7	4					
8	4					
9	4					
10	4					
11	4					
12	4					
						Variation 1½ points westerly.

Variation 1½ points westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S. 37° 45' E.	104	S. 82	E. 64	N. 34° 55'	N. 34° 35'	E. 1° 18'	W. 40° 16'	Funchal S. 84° 17' E. dist. 1174 miles

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. S. E. ¼ E.	40		13.5	57.7	
S. E. ¼ E.	20		13.4	14.8	
S. S. E. ¼ E.	8		7.2	3.4	
S. by E.	16		15.7	3.1	
S. ¼ E.	33		32.6	4.8	
	Diff. Lat.	82.4	63.8		

The courses being corrected for lee-way and variation, will stand as in the adjoined traverse table.

Then with the difference of latitude 82.4 & the departure 63.8, I find the course S. 37° 45' E. Yesterday's latitude 36° 17' N. Difference of latitude 1 22' S.

Lat. by account 34 55 N.

Yesterday's latitude	36° 17' N.
Latitude in by obs.	34 55 N.
Sum of latitudes	70 52
Middle latitude	35 26

With the dep. 63.8 miles, and the mid. lat. 35° 26', I find the diff. of long. to be 78 miles =	1° 18' E.
Yesterday's long.	41 34 W.
Longitude in	40 16 W.

To find the bearing and distance of Funchal.

Latitude in	34° 35' N.	Longitude in	40° 16' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 54 W.
Diff. of latitude	1 57 = 117 miles.	Diff. of longitude	23 22
Middle latitude	33 36		60

In miles 1402

Hence by Case I. Middle Latitude Sailing, the bearing of Funchal is found to be S. 84° 17' E. and its distance 1174 miles.

H.	K.	F.	Courses.	Winds.	L. W.	Remarks on board, Monday, April 5, 1824.		
1	3		S. E.	E.N.E	1	First part of these 24 hours small breezes, and calm; latter part fresh gales. At 4 P. M. got out the boat and tried the current; found it running E. 1 mile per hour, and suppose the ship has been in this current these 24 hours.		
2	3							
3	2							
4	2							
5								
6			Calm.					
7								
8								
9								
10								
11						Mer. alt. sun's lower limb 61° 39'		
12						Correction for semi-diam. &c. 0 12		
1	3	4	E. S. E.	N.N.E		Sun's correct altitude 61 51		
2	3	4				Subtract from 90 00		
3	4	6						
4	4	6				Sun's zenith distance 28 9 N.		
5	5	5				Sun's declination 6 12 N.		
6	5	5						
7	6	5				Observed latitude 34 21 N.		
8	6	5						
9	7							
10	7							
11	8							
12	8					Variation 1½ point westerly.		
Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S. 83° 36' E.	101	S. 11	E. 100	N. 34° 24'	N. 34° 21'	E. 2° 1'	W. 38° 15'	Funchal S 84° 50' distance 107½ miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
S. E. ½ E.	10		6.7	7.4	
E. ½ S.	70		10.3	69.2	
E.N.E. ½ E.	24	5.8		23.9	
		5.2	17.0	21.0	D. p.
			5.8		
		Diff. Lat. 11.2			

In addition to the courses sailed, I also allow 24 miles for the set of the current in the direction of east per compass, or E. N. E. ½ E. true course.

With the difference of latitude 11.2 and the departure 99.9, the course is found to be S. 83° 36' E. and the distance nearly 101 miles.	With the middle lat. 34° 23', and the dep. 99.9, I find the diff. of long. to be 2° 1' E.
Yesterday's latitude 34° 35' N.	Yesterday's longitude 40 16 W.
Difference of latitude 0 11 S.	Longitude in 38 15 W.
Latitude in by account 34 24 N.	

To find the bearing and distance of Funchal.

Latitude in 34° 21' N.	Longitude in 38° 15' W.
Funchal's latitude 32 38 N.	Funchal's longitude 16 54 W.
Difference of lat. 1 43 = 103 miles.	Difference of long. 21 21
Sum of latitudes 66 59	60

Middle latitude 33 30 nearly.

In miles 1281

Hence by Case I. of Middle Latitude Sailing, the bearing of Funchal is found to be S. 84° 30' E. and its distance 107½ miles.

F. Courses.		Winds	L W	Remarks on board, Tuesday, April 6, 1824.				
E. S. E.	North.			Fine fresh gales and clear weather.				
				Mer. alt. sun's lower limb	62° 35'			
				Correction for dip, &c.	0 12			
				Sun's correct altitude	62 47			
				Subtract from	90 00			
				Sun's zenith distance	27 13 N.			
				Sun's declination	6 35 N.			
				Observed latitude	33 48 N.			
Variation per Amp. 1½ point westerly.								
se.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
3.	216	S. 32	E. 214	N. 33° 49'	N. 33° 48'	E. 4° 18'	W. 33° 57'	Funchal S. 85° 19' E. dist. 859 miles.

course corrected for variation is E. ¼ S. distance 216 miles ; hence difference of latitude is 31.7, and the departure 213.7 miles.

Yesterday's latitude	34° 21' N.
Difference of latitude	32 S.
Latitude in	33 48 N.
Sum of latitudes by obs.	68 9
Middle latitude	34 4

h the middle latitude 34° 4', and the departure 213.7 miles, I find the nce of longitude to be 258 miles = 4° 18' E.
Yesterday's longitude 33 15 W.
Longitude in 33 57 W.

To find the bearing and distance of Funchal.

de in	33° 48' N.	Longitude in	33° 57' W.
al's lat.	32 38 N.	Funchal's long.	16 54 W.
f latitude	1 10 = 70 miles.	Diff. of long.	17 3 W.
f latitudes	66 26		60
e latitude	33 13	In miles	1023

ce the bearing of Funchal is found to be S. 85° 19' E. and its distance iles.

JOURNAL OF A VOYAGE

H	K	F.	Courses.	Winds.	LW.	Remarks on board, Wednesday, Ap. 7, 1824.		
1	10		E.S.E.	NNW.		Fresh gales and pleasant weather, with a large sea. At 4 P. M. took a lunar observation by measuring the distance of the moon from the sun; the longitude reduced to noon by the log, was $29^{\circ} 39'$ W.		
2	10							
3	10							
4	10							
5	10							
6	10							
7	8	4			E.S.E. & S		North.	
8	8	4						
9	8	8						
10	8	6						
11	8	5						
12	8	5						
1	8							
2	8							
3	8	5						
4	8	5						
5	8	4						
6	8	4						
7	8	6						
8	8	6						
9	8							
10	8							
11	8							
12	8		Variation per azimuth $1\frac{1}{4}$ point westerly.					
Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S $80^{\circ} 20' E$	210	S. 35	E. 207	N. $33^{\circ} 13'$		E. $4^{\circ} 8'$	W. $29^{\circ} 49'$	Funchal S $86^{\circ} 55' E$ distance 652 miles

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. & S.	60		5.9	59.7	
E. by S.	150		29.3	147.1	
			35.2	206.8	

By the adjoined traverse table, the difference of latitude is 35.2, and the departure 206.8; hence the course was S. $80^{\circ} 20' E$. and the distance 209.8, or 210 miles.

Yesterday's latitude	33° 48' N.	With the middle latitude 33° 30'
Difference of latitude	35' S.	and the departure 206.8, I find the diff.
		of long. 243 miles, or 4° 8' E.
Latitude in by account	33 13' N.	Yesterday's longitude 33 57 W
Sum of latitudes	67 1	
Middle latitude	33 30	Longitude in 29 49 W

To find the bearing and distance of Funchal.

Latitude in	$33^{\circ} 13' N$.	Longitude in	$29^{\circ} 49' W$.
Funchal's latitude	$32^{\circ} 38' N$.	Funchal's longitude	$16^{\circ} 54' W$.
Diff. of latitude	35	Diff. of longitude	$12^{\circ} 55'$
Sum of latitudes	65 51		60
Middle latitude	$32^{\circ} 55'$		

In miles 775

Hence the bearing of Funchal is found to be S. $86^{\circ} 55' E$. and its distance 652 miles.

FROM BOSTON TO MADEIRA.

Courses.	Winds.	L. W.	Remarks on board, Thursday,
y 84 S	N. N. E.		First part fresh gales and clear. part rainy weather.
E.	E. N. E.	1	
			At 6 A. M. the wind hauled suddenly to the S. S. E.
Last.	S. S. E.	1	
Variation 1 1/4 point westerly.			

ist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
72	S. 19	E. 171	N. 32° 54'		E. 3° 24'	W. 26° 25'	Funchal S. 88° 5' E. dist. 480 miles.

TRAVERSE TABLE.

Dist.	N.	S.	E.	W.
0			50.0	
0		14.4	66.5	
0	25.7		51.2	
	25.7	44.4	170.7	Dep.
		25.7		
Diff. Lat. 18.7				

The leeway and variation being allowed on the courses, they will stand as in the adjoined traverse table; then with the difference of latitude 18.7, and the departure 170.7, the course is found to be S. 83° 15' E. and the distance 172 miles.

latitude 33° 13' N. With the middle lat. 33° 3' and the
of latitude 19 S. dep. 170.7, I find the diff. of long. is
nearly 204 miles = 3° 24' E.
tudes 32 54 N. Yesterday's longitude 29 49 W.
ude 66 7
ude 33 3 Longitude in 26 25 W.

To find the bearing and distance of Funchal.

atitude 32° 54' N. Longitude in 26° 25' W.
32 38 N. Funchal's longitude 16 54 W.
tude 18
tudes 65 32
ude 32 46 Diff. of longitude 91

In miles

bearing of Funchal is found to be S. 86° 5' E. as

JOURNAL OF A VOYAGE

H. K.	F.	Courses.	Winds.	L. W.	Remarks on board, Friday, April 9, 1824.			
1	7	5	E. by S. 1 S	South.	Fine breezes, with variable weather.			
2	7	5						
3	8							
4	0							
5	8	5						
6	8	5						
7	9							
8	9							
9	9							
10	9							
11	9							
12	9							
1	9				Mer. alt. sun's lower limb 64° 38'			
2	9				Correction for dip, &c. 0 12			
3	9				Sun's correct altitude 64 45			
4	9				Subtract from 90 00			
5	9				Sun's zenith distance 25 15 N.			
6	9				Sun's declination 7 41 N.			
7	9				Observed latitude 32 56 N.			
8	9	E. by S.						
9	9							
10	9							
11	9							
12	9							
Variation 1½ point westerly.								
Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
N 89° 12' E	210	N. 9	E. 209.5	N. 32° 57'	N. 32° 56'	E. 4° 10'	W. 22° 15'	Funchal, S. 86° 11' E. distance 270 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. $\frac{1}{4}$ S.	120		5.9	119.9	
E. $\frac{1}{4}$ N.	90	8.8		89.6	
		8.8	5.9	209.5	Dep.
		5.9			
Diff. Lat.	2.9				

The variation being allowed on the courses, they will stand as in the adjoined table; then with the difference of latitude 2.9, and the departure 209.5, the course is found to be N. $89^{\circ} 12' \text{ E.}$ and the distance 210 miles nearly.

Yesterday's latitude	32° 54' N.	With the middle lat. 32° 55', and
Difference of latitude	3 N.	the dep. 209.5, the diff. of long. is
	<hr/>	found 250 miles = 4° 10' E.
Latitude by account	32 57 N.	Yesterday's longitude 28 25 W.
		<hr/>
		Longitude in 22 15 W.

To find the bearing and distance of Funchal.

Latitude in	$32^{\circ} 56' \text{ N.}$	Longitude in	$22^{\circ} 15' \text{ W.}$
Funchal's latitude	$32 \quad 38 \text{ N.}$	Funchal's longitude	$16 \quad 54 \text{ W.}$
Difference of latitude	18	Difference of longitude	$5 \quad 21$
Sum of latitudes	$65 \quad 84$		60
Middle latitude	$32 \quad 47$		

In miles 321

Hence the bearing of Funchal is found to be S. $86^{\circ} 11' \text{ E.}$ and its distance 270 miles.

EXPLANATION OF SEA TERMS.



- 1BACK.** The situation of the sails, when their surfaces are pressed aft against the mast by the force of the wind.
- 1bawl or aft.** The sternmost part of the ship; *Carry aft any thing*; that is, carry towards the stern. *The mast rakes aft*; that is, hangs towards the stern. *How cheer ye fore and aft?* that is, how fares all the ship's company?
- 1best the Beam** denotes the relative situation of any object with the ship, when the object is placed in any part of that arch of the horizon, which is contained between a line at right angles with the keel, and that point of the compass which is directly opposite to the ship's course. See Bearing.
- 1board.** The inside of a ship. *Aboard Main Tack!* The order to draw the lower corner of the mainsail down to the chestree.
- 1bout.** The situation of a ship as soon as she has tacked or changed her course.
- 1bout ship!** the order to the ship's crew to prepare for tacking.
- 1breast.** The situation of two or more ships lying with their sides parallel, and their heads equally advanced; in which case they are abreast of each other.
- 1drift.** The state of a ship broken from her moorings, and driving about without control.
- 1float.** Buoyed up by the water from the ground.
- 1fore.** All that part of a ship which lies forward or near the stem. It also signifies further forward.
- 1fter.** A phrase applied to any object in the hinder part of the ship, as the after-hatchway, the after-sails, &c.
- 1ground.** The situation of a ship when her bottom or any part of it rests on the ground.
- 1-head.** Any thing which is situated on that point of the compass to which a ship's stem is directed, is said to be ahead of her. See Bearing.
- 1-hull.** The situation of a ship when all her sails are furled and her helm is lashed to the lee side; by which she lies nearly with her side to the wind and sea, her head being somewhat inclined to the direction of the wind.
- 1-lee.** The position of the helm when it is put down to the lee side.
- 1ll in the winn.** The state of a ship's sails, when they are parallel to the direction of the wind, so as to shake or shiver.
- 1ll-hands-shoy!** The call by which all the ship's company are summoned upon deck.
- 1loft.** Up in the tops, at the mast heads, or any where about the higher rigging.
- 1long-side.** Side by side, or joined to a ship, wharf, &c.
- 1long-shore.** Along the coast; a course which is in sight of the shore, and nearly parallel to it.
- 1loof is distance.** Keep aloof, that is, keep at a distance.
- 1main.** The old term for yield, used by a man of war to an enemy; but it now signifies any thing done suddenly, or at once, by a number of men.
- 1midships.** The middle of a ship, either with regard to her length or breadth.
- 1nchor.** The instrument by which a ship is held. *The anchor is foul*; that is, the cable has got about the fluke of the anchor. *The anchor is a-peak*; that is, directly under the hawse-hole of the ship. *The anchor is a cock bill*; that is, hangs up and down the ship's side.
- 1n-end.** The position of any mast, &c. when erected perpendicularly on the deck. The top-masts are said to be an end, when they are hoisted up to their usual station.
- 1-peak.** Perpendicular to the anchor; the cable having been drawn so tight as to bring the ship directly over it. The anchor is then said to be a-peak.
- 1shore.** On the shore, as opposed to aboard. It also means aground.
- 1stern.** Any distance behind a ship, as opposed to ahead. See Bearing.
- 1t Anchor.** The situation of a ship riding by her anchor.
- 1thwart.** Across the line of a ship's course. *Athwart Haulse*; the situation of a ship when driven by accident across the fore part of another; whether they touch, or are at a small distance from each other, the transverse position of the former being principally understood. *Athwart the Fore Foot*; when any object crosses the line of a ship's course, but ahead of her, it is said to be athwart the Fore Foot. *Athwart ships*; reaching, or in a direction, across the ship from one side to the other.
- 1trip.** When applied to the anchor, it means that the anchor is drawn out of the ground, and hangs in a perpendicular direction, by the cable or buoy rope. The top-sails are said to be atrip, when they are hoisted up to the mast head, or to their utmost extent.
- 1rust.** A term used for stop, or stay; as, *waist heaving*, do not heave any more.
- 1weigh.** The same as atrip when applied to the anchor.
- 1wining.** A shelter or screen of canvass spread over the decks of a ship, to keep off the

- the heat of the sun. *Spread the awning* ; extend it so as to cover the deck. *Furl the awning* ; that is, roll it up.
- To back the Anchor.* To carry out a small anchor ahead of the large one, in order to support it in bad ground, and to prevent it from loosening or coming home.
- To back astern.* In rowing, is to impel the boat with her stern foremost, by means of the oars.
- To back the sails.* To arrange them in a situation that will occasion the ship to move astern.
- To bagpipe the mizen.* To lay it aback, by bringing the sheet to the mizen shrouds.
- To balance.* To contract a sail into a narrower compass, by folding up a part at one corner. Balancing is peculiar only to the mizen of a ship, and the mainsail of those vessels wherein it is extended by a boom.
- Bale.* Bale the boat ; that is, to throw the water out of her.
- Ballast,* is either pigs of iron, stones or gravel, which last is called *shingle ballast* ; and its use is to bring the ship down to her bearings in the water, which her provisions and stores will not do. *Trim the ballast* ; that is, spread it about and lay it even. *The Ballast shoots* ; that is, it shifts, or runs over from one side of the hold to the other.
- Bare poles.* When a ship has no sail set, she is under bare poles.
- Barge.* A carval built boat, that rows with ten or twelve oars.
- Batten.* A thin piece of wood. *Batten down the hatches,* is to lay battens upon the tarpaulins, which are over the hatches in bad weather, and nail them down that they may not be washed off.
- Beacon.* A post or stake erected over a shoal or sand bank, as a warning to seamen to keep at a distance. Also, a signal placed at the top of hills, &c.
- Beams.* Strong pieces of timber stretching across a ship's side to side, to support the decks, and retain the sides at their proper distance.
- Bear a-hand.* Make haste, despatch.
- Bearing* signifies the point of the compass which any two or more places bear from each other, or how any place bears from the ship by the compass ; or it may be said to bear on the beam, abaft the beam, on the bow, the head or stern, &c.
- Bearings* of a ship, is that line which is formed by the water upon her sides when she is at anchor, with her proportion of ballast and stores on board. *To bear to,* is to sail into an harbour, &c. *Bear round up* ; that is, put her right before the wind. *Bring your guns to bear,* is to point them to the object.
- To bear in* with the land, is when a ship sails towards the shore.
- To Bear off.* To thrust or keep off from the ship's side, &c. any weight when hoisting.
- Bearing up or Bearing away.* The act of changing the course of a ship, in order to make her run before the wind, after she had sailed sometime with a side wind, or close hauled ; it is generally performed to arrive at some port under the lee, or to avoid some imminent danger occasioned by a violent storm, leak, or enemy in sight.
- Beating to Windward.* The making a progress against the direction of the wind, by steering alternately close hauled on the starboard and larboard tacks.
- To becalm.* To intercept the current of the wind, in its passage to a ship, by any contiguous object, as a shore above her sails, a high sea behind, &c. and thus one sail is said to becalm another.
- Before the Beam,* denotes an arch of the horizon comprehended between the line of the beam (which is at right angles to the keel) and that point of the compass on which the ship stems. See *Bearing*.
- Belay.* To make fast any running rope, as *Belay the main brace,* or make it fast.
- Bend.* To apply to and fasten ; as, bend the sails, apply them to the yards and fasten them : unbend the sails, that is, cast them off, and take them from the yards ; her sails are unbent. she has none fixed : bend the cable, make it fast to the anchor.
- Beneaped.* See *Neaped*.
- Between Decks.* The space contained between any two decks of a ship.
- Bight of a rope.* The double part of a rope when it is folded. *Bight,* a narrow inlet of the sea.
- Bilge.* To break. The ship is bilged ; that is, her planks are broken in by violence.
- Bilge-Water,* is that which, by reason of the flatness of a ship's bottom, lies on her floor and cannot go to the well of the pump.
- Binnacle.* A kind of box to contain the compasses in upon deck.
- Birth.* A place ; as *the ship's birth,* the place where she is moored ; *an officer's birth,* his place in the ship to eat or sleep in ; *birth the ship's company,* that is, allot them their places to mess in ; *birth the hammocks,* point out where each man's hammock is to hang.
- Bitts.* Very large pieces of timber in the fore part of a ship, round which the cables are fastened when the ship is at anchor. *After-Bitts,* a smaller kind of bitts upon the quarter-deck, for belaying the running rigging to.
- To Bitt the Cable,* is to confine the Cable to the bitts, by one turn under the cross piece,

and another turn round the bitt-head. In this position it may be either kept fixed, or it may be veered away.

Bitter. The turn of the cable round the bitts. *Bitter end*; that part of the cable which stays within board, round about the bitts, when the ship is at anchor.

Block. A piece of wood with running sheaves or wheels in it, through which the running rigging is passed to add to the purchase.

Board. To board a ship is to enter it in a hostile manner.

Board. To make a *board* is making a stretch upon any tack when a ship is working upon a wind. *To board it up*, that is, to turn to windward. *The ship has made a stern board*, that is, when she loses ground in working upon a wind.

Boatswain. The officer who has charge of all the cordage, rigging, anchors, &c.

Bold shore. A steep coast, permitting the close approach of shipping.

Bolt rope. The rope which goes round a sail, and to which the canvass is sewed. The side ropes are called *leach ropes*, that at the top the *head rope*, and that at the bottom the *foot rope*.

Bonnet of a sail, is an additional piece of canvass put to the sail in moderate weather to hold more wind. *Lase on the bonnet*, that is, fasten it to the sail. *Shake off the bonnet*, take it off.

Boot topping. Cleaning the upper part of a ship's bottom, or that part which lies immediately under the surface of the water, and daubing it over with tallow, or with a mixture of tallow, sulphur, rosin, &c.

Both sheets aft. The situation of a ship sailing right before the wind.

Bow grace. A frame of old rope or junk, laid out at the bows, stems, and side of ships, to prevent them from being injured by flakes of ice.

Bow lines. Lines made fast to the sides of the sails to haul them forward when upon a wind, which being hauled taut, enables the ship to come nearer to the wind.

To bower. To pull upon any body with a tackle in order to remove it.

Bowsprit. A large mast or piece of timber which stands out from the bows of a ship.

Boxhauling. A particular method of veering a ship, when the swell of the sea renders tacking impracticable.

Boring. An operation somewhat similar to Boxhauling. It is performed by laying the head sails aback, to receive the greatest force of the wind in a line perpendicular to their surfaces, in order to turn the ship's head into the line of her course, after she has inclined to windward of it.

Braces. The ropes by which the yards are turned about to form the sails to the wind.

To brace the yards. To move the yards, by means of the braces, to any direction required.

To brace about—to brace the yards round for the contrary tack. *To brace sharp*—to brace the yards to a position in which they will make the smallest possible angle with the keel, for the ship to have head-way. *To Brace to*—to ease off the lee braces, and round in the weather braces, to assist the motion of the ship's head in tacking.

Brails. A name peculiar only to certain ropes belonging to the mizen, used to truss it up to the mast. But it is likewise applied to all the ropes which are employed in hauling up the bottoms, lower corners and skirts of the other great sails. *To brail up*—to haul up a sail by means of the brails, for the more ready furling it when necessary.

To break bulk. The act of beginning to unload a ship.

To break sheer. When a ship at anchor is forced, by the wind or current, from that position in which she keeps her anchor most free of herself and most firm in the ground, so as to endanger the tripping of her anchor, she is said to break her sheer.

Brenning. Burning off the filth from a ship's bottom.

Breast-fast. A rope employed to confine a ship sideways to a wharf or to some other ship.

To bring by the lee.—See *to broach to*.

To bring to. To check the course of a ship when she is advancing, by arranging the sails in such a manner that they shall counteract each other, and prevent her from either retreating or advancing. See *to lie to*.

To broach to. To incline suddenly to windward of the ship's course, so as to present her side to the wind, and endanger her oversetting. The difference between *broaching to* and *bringing by the lee* may be thus defined: Suppose a ship under great sail is steering south, having the wind at N. N. W. then west is the weather-side, and east the lee-side. If, by any accident, her head turns round to the westward, so that her sails are all taken a-back on the weather side, she is said to *broach to*. If, on the contrary, her head declines so far eastward as to lay her sails aback on that side which was the lee side, it is called *bringing by the lee*.

Broadside. A discharge of all the guns on one side of a ship both above and below.

Broken backed. The state of a ship which is so loosened in her frame as to drop at each end.

By the board. Over the ship's side.

By the head. The state of a ship when she is so unequally loaded as to draw more water forward than aft.

By the wind. The course of a ship as near as possible to the direction of the wind, which is generally within six points of it.

Bunt-lines. Ropes fastened to the foot rope of square sails to draw them up to the middle of the yards for furling.

Bucy. A floating conical cask, moored upon shoals to show where the danger is; also used at anchors to show where they lie, in case the cable breaks.

C'ap. A strong thick block of wood, having two large holes through it, the one square, the other round; used to confine the two masts together.

Capsize. Overturn—the boat is capsized, that is, overset. Capsize the quail of rope; that is, turn it over.

Capstan. An instrument by which the anchor is weighed out of the ground, used also for setting up the shrouds, and other work where a great purchase is required.

To Carcen. To incline a ship on one side so low down, by shifting the cargo or stores on one side, that her bottom on the other side may be cleansed by breaming.

To carry away. To break—as a ship has carried away her bowsprit, that is, has broken it off.

Casting. The motion of falling off, so as to bring the direction of the wind on either side of the ship after it had blown sometime right a-head. It is particularly applied to a ship about to weigh anchor.

Cat-Heads. The timbers on ship's bows with sheaves in them, by which the anchor is hoisted after it has been hove up by the cable.

To cat the anchor is to hook the cat-block to the ring of the anchor, and haul it up close to the cat-head.

Cal's paw is a light air of wind perceived at a distance in a calm, sweeping the surface of the sea very lightly, and dying away before it reaches the ship.

Caulking is filling the seams of a ship with oakum.

Centre. This word is applied to that squadron of a fleet, in a line of battle, which occupies the middle of a line; and to that column (in the order of sailing) which is between the weather and lee columns.

Chains. A place built on the sides of the ship projecting out, and at which the shrouds are fastened, for the purpose of giving them greater angle than they could have if fastened to the ship's side, and of course giving them a greater power to secure the mast.

Chain plates, are plates of iron fastened to the ship's sides under the chains, and to these plates the dead eyes are fastened.

Chapelling. The act of turning a ship round in a light breeze of wind when she is close hauled, so that she will lie the same way she did before. This is usually occasioned by negligence in steering, or by a sudden change of wind.

Chase. A vessel pursued by some other. *Chaser*—the vessel pursuing.

Cheerly. A phrase implying heartily, quickly, cheerfully.

To claw off. The act of turning to windward from a lee shore, to escape shipwreck, &c.

Clear is variously applied:—The weather is said to be clear when it is fair and open, the sea-coast is clear when the navigation is not interrupted by rocks, &c. It is applied to cordage, cables, &c. when they are disentangled, so as to be ready for immediate service. In all these senses it is opposed to *foul*. *To clear the anchor* is to get the cable off the flukes, and to disencumber it of ropes, ready for dropping. *Clear hawse*—When the cables are directed to their anchors without lying athwart the stem. *To clear the hawse* is to untwist the cables when they are entangled by heaving either a cross, an elbow or a round turn.

C'lenched. Made fast, as the cable is to the ring of the anchor.

Close hauled. That trim of the ship's sails, when she endeavours to make a progress in the nearest direction possible towards that point of the compass from which the wind blows.

To club haul. A method of tacking a ship when it is expected she will miss stays on a lee shore.

C'ue-lines, are ropes which come down from the mast to the lower corners of the sails, and by which the corners or clues of the sails are hauled up.

C'ue of a sail. The lower corners of square sails, but the aftermost only of stay sails, the other lower corner being called the tack.

To c'ue up. To haul up the clues of a sail to its yard by means of the c'ue lines.

Coasting. The act of making a progress along the sea-coast of any country.

To coil the cable. To lay it round in a ring, one turn over another.

To come home. The anchor is said to come home when it loosens from the ground by the effort of the cable, and approaches the place where the ship floated, at the length of her moorings.

Coming to, denotes the approach of a ship's head to the direction of the wind.

Course. The point of the compass upon which the ship sails. *Courses,* a ship's lower sails; as the fore-sail is the fore-course; the main-sail the main-course, &c.

EXPLANATION OF SEA TERMS.

223

The ship is under her courses; that is, has no sail set but the main-sail, fore-sail and mizen.

Coastman. The person who steers the boat.

Crack. The ship is crack, that, is she has not a sufficient cargo or ballast to render her capable of bearing sail, without being exposed to the danger of oversetting.

Crew-foot, is a number of small lines spread from the fore parts of the tops, by means of the piece of wood through which they pass, and being hauled taut upon the stays, they prevent the foot of the topsails catching under the top rim; they are also used to suspend the awnings.

Van. To direct. To van a ship is to direct the man at helm how to steer.

To cut and run. To cut the cable and make sail instantly, without waiting to weigh anchor.

Davit. A long beam of timber, used as a crane, whereby to hoist the flukes of the anchor to the top of the bow, without injuring the planks of the ship's sides as it ascends. There is always a Davit of a smaller kind fixed to the long-boat to weigh the anchor by the buoy-rope.

To deaden a ship's way. To impede her progress through the water.

Dead eyes. Blocks of wood through which the laniards of the shrouds are reeved.

Dead lights. A kind of window shutter for the windows in the stern of a ship, used in very bad weather only.

Dead water. The eddy of water, which appears like whirlpools, closing in with the ship's stern as she sails on.

Dead-wind. The wind right against the ship, or blowing from the very point to which she wants to go.

Dismasted. The state of a ship that has lost her masts.

Dog-sun. A small vane with feathers and cork, and placed on the ship's quarter, for the men at gun and helm to see the course of wind by.

Dog-watch. The watches from four to six and from six to eight in the evening.

Doubling. The act of sailing round or passing beyond a cape or point of land.—Doubling upon.—The act of inclosing any part of a hostile fleet between two fires, or of cannonading it on both sides.

Douce. To strike or haul down; as, douce the top-gallant sails, that is, lower them.

Down haul. The rope by which any sail is hauled down, as the jib down-haul.

To douse. To lower suddenly or slacken.

To drag the anchor. To trail it along the bottom after it is loosened from the ground.

To draw. When a sail is inflated by the wind, so as to advance the vessel in her course, the sail is said to draw; and so to keep all drawing is to inflate all the sails.

Drift. The angle which the line of a ship's motion makes with the nearest meridian, when she drives with her side to the wind and waves, and not governed by the power of the helm. It also implies the distance which the ship drives on that line.

Driver. A large sail set upon the mizen yards in light winds. *Drive.*—The ship drives, that is, her anchor comes through the ground.

Drop. Used sometimes to denote the depth of a sail; as the fore-top-sail drops twelve yards.

To drop anchor. Used synonymously with *to anchor*. To drop astern. The retrograde motion of a ship.

Damage. A quantity of loose wood, &c. laid at the bottom of a ship to keep the goods from being damaged.

Earrings. Small ropes used to fasten the upper corners of sails to the yards.

To ease, to ease away, or to ease off. To slacken gradually; thus they say, ease the bow-line, ease the sheet.

Ease the ship. The command given by the pilot to the steersman, to put the helm hard-a-lee, when the ship is expected to plunge her fore part deep in the water when close-hauled.

To edge away. To decline gradually from the shore or from the line of the course which the ship formerly held in order to go more large.

To edge in with. To advance gradually towards the shore, or any other object.

Elbow in the Hawse. Is when a ship, being moored, has gone round upon the shifting of the tides twice the wrong way, so as to lay the cables one over the other: having gone once wrong, she makes a cross in the hawse, and going three times wrong, she makes a round turn.

End for end. A term used when a rope runs all out of a block, and is unreeved, or in coming to an anchor, if the stoppers are not well put on and the cable runs all out, it is said to have gone out end for end.

End on. When a ship advances to a shore, rock, &c. without an apparent possibility of preventing her, she is said to go end on for the shore, &c.

Engagement. Action or fight.

Ensign. The flag worn at the stern of a ship.

Entering port. A large port in the side of three deckers leading into the middle deck, to save the trouble of going up the ship's side to get on board.

- Even keel.** When the keel is parallel with the horizon, a ship is said to be upon an *even keel*.
- Fair.** A general term for the disposition of the wind, when favourable to a ship's course.
- Fair-way.** The channel of a narrow bay, river, or haven, in which ships usually advance in their passage up and down.
- Pack, or Fake.** One circle of any rope or cable coiled.
- Fag end.** The end of any rope which is become untwisted by frequent use; to prevent which the ends of ropes are wound round with pieces of twine, which operation is called *whipping*.
- To fall a-board of.** To strike or encounter another ship when one or both are in motion.
- To fall astern.**—The motion of a ship with her stern foremost. **To fall calm.** To become in a state of rest by a total cessation of the wind. **To fall down.** To sail or be towed down a river nearer towards its mouth.
- Falling off** denotes the motion of the ship's head from the direction of the wind. It is used in opposition to *coming to*.
- Fall not off, or nothing off.** The command of the steersman to keep the ship near the wind.
- Fathom.** A measure of six feet.
- To fetch away.** To be shaken or agitated from one side to another so as to loosen any thing which before was fixed.
- Fid.** A square bar of wood or iron, with shoulders at one end, used to support the weight of the topmast, when erected at the head of a lower-mast.
- Fid for splicing.** A large piece of wood of a conical figure; used to extend the strands and layers of cables in splicing.
- To fill.** To brace the sails so as to receive the wind in them, and advance the ship in her course, after they had been either shivering or braced a-back.
- Fish.** A large piece of wood. **Fish the mast;** apply a large piece of wood to it to strengthen it.
- Fish-hook.** A large hook by which the anchor is received and brought to the cat-head; and the tackle which is used for this purpose is called the fish-tackle.
- To fish the anchor.** To draw up the flukes of the anchor towards the top of the bow, in order to stow it, after having been catted.
- Flag.** A general name for colours worn and used by ships of war.
- Flat aft.** The situation of the sails when their surfaces are pressed aft against the mast by the force of the wind.
- To flat in.** To draw in the aftermost lower corner, or clue, of a sail towards the middle of the ship, to give the sail a greater power to turn the vessel. **To flat in forward.** To draw in the fore sheet, jibb-sheet, and fore-staysail sheet, towards the middle of the ship.
- Flaw.** A sudden breeze or gust of wind.
- Floating.** The state of being buoyed up by the water from the ground.
- Flood-tide.** The state of a tide when it flows or rises.
- Flouring sheets.** The position of the sheets of the principal sails when they are loosened from the wind so as to receive it into their cavities more nearly perpendicular than when close-hauled, but more obliquely than when the ship sails before the wind. A ship going two or three points large has *flouring sheets*.
- Fore.** That part of a ship's frame and machinery that lies near the stem. **Fore and aft.** Throughout the whole ship's length. Lengthways of the ship.
- Fore-reach.** To shoot a-head, or go past another vessel.
- To force over.** To force a ship violently over a shoal by a great quantity of sail.
- Forward.** Towards the fore part of a ship.
- Foul.** Is used in opposition both to clear and fair. As opposed to clear we say, foul weather, foul bottom, foul ground, foul anchor, foul hawse. As opposed to fair, we say foul wind.
- To founder.** To sink at sea by filling with water.
- To free.** Pumping is said to free the ship when it discharges more water than leaks into her.
- To freshen.** When a gale increases it is said to freshen. **To freshen the Hawse.** Veering out or heaving in a little cable to let another part of it endure the stress of the hawseholes. It is also applied to the act of renewing the service round the cable at the hawscholes.
- Freshen the ballast.** Divide or separate it.
- Fresh away.** When a ship increases her velocity, she is said to get fresh way.
- Full.** The situation of the sails, when they are kept distended by the wind.
- Full and by.** The situation of a ship, with regard to the wind, when close hauled and sailing, so as to steer neither too nigh the direction, nor to deviate to leeward.
- To furl.** To wrap or to roll a sail close up to the yard or stay to which it belongs, and winding a cord around it, to keep it fast.
- Gage of the ship.** Her depth of water, or what water she draws.

- To gain the wind.** To arrive on the weather side, or to windward of some ship or fleet in sight, when both are sailing as near the wind as possible.
- Gunnen the bowsprit.** Secure it by turns of a strong rope passed round it, and into the cat-water, to prevent it from having too much motion.
- Gangway.** That part of a ship's side both within and without, by which persons enter and depart.
- Garboard streak.** The first range or streak of planks laid in a ship's bottom next the keel.
- Gasket.** The rope which is passed round the sail to bind it to the yard when it is furled.
- To gather.** A ship is said to gather on another as she comes nearer to her.
- Gimblating.** The action of turning the anchor round by the stock, so that the motion of the stock appears similar to that of the handle of a gimblet, when employed to turn the wire.
- Girt.** The ship is girt with her cables when she is too tight moored.
- To give chase to.** To pursue a ship or fleet.
- Goose-wings of a sail.** The clues or lower corners of a ship's mainsail or foresail, when the middle part is furled or tied up to the yard.
- Grappling-iron.** A thing in the nature of an anchor, with four or six flukes to it.
- Grease.** To burn off the filth from a ship's bottom.
- Gripe of a ship.** That thin part of her which is under the counter; and to which the sternpost joins. The ship gripes, that is, turns her head too much to the wind.
- Grounding.** The laying the ship a-shore, in order to repair her. It is also applied to running aground accidentally.
- Ground tackle.** Every thing belonging to a ship's anchors, and which are necessary for anchoring or mooring; such as cables, hawsers, tow-lines, warps, buoy-ropes, &c.
- Ground tier.** That is, the tier of water casks which is lowest in the hold, and is among the shingle ballast.
- Growing.** Stretching out; applied to the direction of the cable from the ship towards the anchors: as, the cable grows on the starboard bow.
- Grummet.** A piece of rope laid into a circular form, and used for large boat's oars instead of rowlocks, and also for many other purposes.
- Gunnel.** The upper edge of a ship's side.
- Gun-room.** A division of the lower deck abaft, enclosed with network, for the use of the gunner and his stores.
- Gybing.** The act of shifting any boom-sail from one side of the mast to the other.
- Hail.** To call to another ship.
- Haliards.** The ropes by which the sails are hoisted, as the top-sail haliards, or jibb haliards, &c.
- Handling.** The same as furling.
- Hard a-weather.** Put the tiller quite up to windward.
- Head. Pull.**
- To head the wind.** To direct the ship's course nearer to the point from which the wind blows.
- Hawse-holes.** The holes in the bows of the ship through which the cables pass.—*Freshen hawse,* veer out more cable. *Clap a service in the hawse;* put somewhat round the cable at the hawse-hole to prevent its chafing. *To clear hawse,* is to untwist the cables where a ship is moored, and has got a foul hawse. *Athwart hawse,* is to be across or before another ship's head.
- Hawser.** A small kind of cable.
- Head fast.** A rope employed to confine the head of a ship to a wharf or to some other ship. **Headmost.** The situation of any ship or ships which are the most advanced in a fleet. **Head sails.** All the sails which belong to the foremast and bowsprit.
- Head-see.** When the waves meet the head of a ship in her course, they are called a head-see. It is likewise applied to a single wave coming in that direction.
- Head to-wind.** The situation of a ship when her head is turned to the point from which the wind blows, as it must when tacking.
- Head-way.** The motion of advancing, used in opposition to stern-way.
- To Heave.** To turn about a capstan, or other machine of the like kind, by means of bars, handspikes, &c. *To Heave a-head,* to advance the ship by heaving-in the cable or other rope fastened to an anchor at some distance before her. *To Heave a-peek,* to heave-in the cable, till the anchor is a-peek.
- To Heave a-stern,** to move a ship backwards by an operation similar to that of heaving a-head. *To Heave down,* to careen. *To Heave in the cable,* to draw the cable into the ship, by turning the capstan. *To Heave in stays,* to bring a ship's head to the wind, by a management of the sails and rudder, in order to get on the other tack. *To Heave out,* to unfurl or loose a sail; more particularly applied to the stay-sails; thus we say, loose the topsails and heave out the staysails. *To Heave short,* to draw so much of the cable into the ship, as that she will be almost perpendicularly over her anchor. *To Heave tight or land,* to turn the capstan round till the rope or cable becomes straightened, *To Heave the capstan,* to turn it round. *To Heave the*

- Lead*, to throw the lead overboard, in order to find the depth of water. To *Heave the log*, to throw the log overboard, in order to calculate the velocity of the ship's way. *Heave the capstan*, that is, turn it round with the bars. *Heave handsomely*, heave gently or leisurely. *Heave hearty*, heave strong and quick.
- Heave of the sea*, is the power that the swell of the sea has upon a ship in driving her out, or faster on, in her course, and for which allowance is made in the day's work.
- Heel, or incline*. She heels to port, that is, inclines or lays down upon her larboard or left side.
- Helm*. The instrument by which the ship is steered, and includes both the wheel and the tiller, as one general term. *Helm's a-lee*, that is, the tiller is quite down to leeward.
- High and dry*. The situation of a ship when so far run aground as to be seen dry upon the strand.
- Hitch*. To make fast.
- Hoist*. To haul, sway, or lift up.
- Hold*, is the space between the lower deck and the bottom of the ship, where her stores &c. lie.
- To stow the hold*, is to place the things in it.
- To hold its own*, is applied to the relative situation of two ships when neither advances upon the other; each is then said to hold its own. It is likewise said of a ship which, by means of contrary winds, cannot make a progress towards her destined port, but which, however, keeps nearly the distance she had already run.
- Home*, implies the proper situation of any object; as, to *haul home* the topsail sheets, is to extend the bottom of the topsail to the lower yard, by means of the sheets. In stowing a hold, a cask, &c. is said *to be home*, when it lies close to some other object.
- Hulk*. A ship without masts or rigging; also a vessel to remove masts into or out of ships by means of sheers, from whence they are called *sheer hulks*.
- Horse*. A rope reaching from the middle of a yard to its arms or extremities, for the men to stand on when they are loosing, reefing, or furling a sail.
- Hull* of the ship, the body of it. *To lay a hull*, is to lay to with only a small sail in a gale of wind. *To hull a vessel*, is to fire a shot into any part of her hull.
- Hull down*, is when a ship is so far off that you can only see her masts. *To hull a ship*—to fire cannon balls into her hull within the point-blank range. *Hull to*—the situation of a ship when she lies with all her sails furled: as in *trying*.
- In stays*. See *to heave in stays*.
- Jamming*. The act of enclosing any object between two bodies so as to render it immovable.
- Jeer blocks*. The blocks through which jeers are reeved.
- Jeers*. The ropes by which the lower yards are suspended.
- Jibb*. The foremost sail of a ship, set upon a boom which runs out upon the bowsprit.
- Jibb-boom*. A spar that runs out upon the bowsprit.
- Jolly-boat*. A small boat.
- Junk*. Old cable, or old rope.
- Jury-mast*. A temporary or occasional mast erected in a ship in the place of one which has been carried away by accident, &c.
- Kedge*. A small anchor with an iron stock.
- Keel*. The principal piece of timber in a ship, which is usually first laid on the blocks in building.
- Keel-haul*. To drag a person backwards and forwards under a ship's keel for certain offences.
- Keekled*. Any part of a cable, covered over with old ropes, to prevent its surface from rubbing against the ship's bow or fore-foot.
- To keep away*. To alter the ship's course to one rather more large, for a little time, to avoid some ship, danger, &c. *Keep away* is likewise said to the steersman who is apt to go to windward of the ship's course. *To keep full*—To keep the sails distended by the wind. *To Keep hold of the land*—to steer near to or in sight of the land. *To Keep off*—to sail off or keep at a distance from the shore. *To Keep the land aboard*—the same as *to keep hold of the land*. *To Keep the Luff*—to continue close to the wind. *To keep the wind*—the same as *to keep the luff*.
- Kelson*. A piece of timber forming the interior of the keel; being laid on the middle of the floor timbers immediately over the keel, and serving to unite the former to the latter.
- Kentledge*. Pigs of iron for ballast, laid upon the floor, near the kelson, fore and aft.
- Kenk*. A sort of twist or turn in a cable or rope.
- Knippers*. A large kind of plated rope, which being twisted round the messenger and cable in weighing, bind them together.
- Knot*. A division of the log-line, answering in the calculation of the ship's velocity, to one mile.
- To Labour*. To roll or pitch heavily in a turbulent sea.

- Laden in Bulk.** Freighted with a cargo not packed, but lying loose, as corn, salt, &c.
- Laid up.** The situation of a ship when moored in a harbour, for want of employ.
- Land fall.** The first land discovered after a sea voyage. Thus a good *land fall* implies the land expected or desired; a *bad land fall* the reverse.
- Land-locked.** The situation of a ship surrounded with land, so as to exclude the prospect of the sea, unless over some intervening land.
- Lantards of the shrouds,** are the small ropes at the ends of them, by which they are hove taut or tight.
- Larboard.** The left side of a ship, looking towards the head. **Larboard Tack**—the situation of a ship when sailing with the wind blowing upon her larboard side.
- Lash.** To bind.
- Lamch-ho,** signifies high enough, or lower.
- Laying the land.** A ship which increases her distance from the coast, so as to make it appear lower and smaller, is said to *lay the land*.
- Leading-wind.** A fair wind for a ship's course.
- Leak.** A chink or breach in the sides or bottom of a ship, through which the water enters into the hull.
- Lee.** That part of the hemisphere to which the wind is directed, to distinguish it from the other part which is called to windward. **Lee Gage**—a ship or fleet to leeward of another is said to have the lee-gage. **Lee-Lurches**—the sudden and violent rolls which a ship often takes to leeward, in a high sea, particularly when a large wave strikes her on the weather-side. **Lee-Quarter**—that quarter of a ship which is on the lee side. **Lee-Shore**—that shore upon which the wind blows. **Lee-side**—that half of a ship lengthwise, which lies between a line drawn through the middle of her length and the side which is farthest from the point of wind. **To Lee-ward**—towards that part of the horizon to which the wind blows. **Lee-ward-Ship**—a ship that falls much to leeward of her course, when sailing close hauled. **Lee-ward Tide**—a tide that sets to leeward.
- Lee-Way.** The lateral movement of a ship to leeward of her course; or the angle which the line of her way makes with a line in the direction of her keel.
- To Lie along.** To be pressed down sideways by a weight of sail in a fresh wind.
- Leeches.** The borders or edges of a sail.
- To Lie to.** To retard a ship in her course, by arranging the sails in such a manner as to counteract each other with nearly an equal effort, and render the ship almost immovable with respect to her progressive motion or head way.
- List.** The ropes which come to the ends of the yards from the mast-heads, and by which they are suspended when lowered down.
- Limbers, or Limber-holes.** Square holes cut through the lower part of a ship's floor timbers, very near the keel, forming a channel for water, and communicating with the pump-well throughout the whole length of the floor.
- List.** Incline. The ship has a list to port, that is, she heels to the larboard.
- Log, and Log line,** by which the ship's path is measured, and her rate of going ascertained.
- Log-board,** on which is marked the transactions of the ship, and from thence it is copied into the log-book every 24 hours.
- A Long Sea.** A uniform motion of long waves.
- Look out.** A watchful attention to some important object or event that is expected to arise. Thus persons on board of a ship are occasionally stationed to look out for signals, other ships, for land, &c.
- To Loose.** To unfurl or cast loose any sail.
- To Lower.** To ease down gradually.
- Luff.** The order to the steersman to put the helm towards the lee side of the ship in order to sail nearer to the wind.
- To make a board.** To run a certain distance upon one tack, in beating to windward. **To make foul water**—to muddy the water, by running in shallow places, so that the ship's keel disturbs the mud at the bottom. **To make sail**—to increase the quantity of sail already set, either by unreefing or by setting others. **To make stern way**—to retreat or move with the stern foremost. **To make the land**—To discover it from afar. **To make water**—to leak.
- To man the yard &c.** To place men on the yard, in the tops, down the ladder, &c. to execute any necessary duties.
- Mast.** The upright timber or trees on which the yards and sails are set.
- Masted.** Having all her masts complete.
- Mend the service.** Put on more service.
- Messenger.** A small kind of cable which being brought to the capstan, and the cable by which the ship rides made fast to it, it purchases the anchor.
- To middle a rope.** To double it into two equal parts.
- Mis'ship.** See *And'ships*.

- To miss stays.** A ship is said to *miss stays* when her head will not fly up into the direction of the wind, in order to get her on the other tack.
- Mizen mast.** The mast which stands abaft, and from which its rigging and sails are named; as of the sails, mizen, mizen-top-sail, &c. and so also are the other sails, &c. named from the other masts.
- Moor,** is to secure a ship with two anchors. **Mooring**—securing a ship in a particular station by chains or cables, which are either fastened to an adjacent shore or to anchors at the bottom. **Mooring service**—when a ship is moored, and rides at one cable's length, the mooring service is that which is at the first splice.
- Mouse.** A kind of ball or knob, wrought upon the collar of the stays.
- Must.** To assemble.
- Narrows.** A small passage between two lands.
- Neape Tides.** The tides in the first and last quarter of the moon, and are not either so high, so low, or so rapid as spring tides. A ship is said to be *benesped* when she has not water enough to take her off the ground, or over the bar, &c.
- Near, or nonear.** An order to the steersman not to keep the ship so close to the wind.
- Nippers.** Certain pieces of cordage used to fasten the messenger to the cable in heaving up the anchor.
- Nothing off.** A term used by the man at the cun to the steersman, directing him not to go from the wind.
- Nun buoy.** The kind of buoys used by ships of war.
- Oakum.** Old rope untwisted and pulled open.
- Off and on.** When a ship is beating to windward, so that by one board she approaches towards the shore, and by the other stands out to sea, she is said to stand *off and on* shore.
- Offing.** To seaward from the land. *A ship is in the offing*, that is, she is to seaward, at a distance from the land. *She stands for the offing*, that is, towards the sea.
- Offward.** From the shore, as when a ship lies aground and leans towards the sea, she is said to heel *offward*.
- On board.** Within the ship, as, he is come on board.
- On the beam.** Any distance from the ship on a line with the beams, or at right angles with the keel. See *Bearing*.
- On the bow.** An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's head is directed. Thus, they say, the ship in sight bears three points on the starboard bow; that is, three points towards the right hand, from that part of the horizon which is right a-head. See *Bearing*.
- On the quarter.** An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's stern is directed. See *On the bow*.
- Open.** The situation of a place exposed to the wind and sea. It is also expressed of any distant object to which the sight or passage is not intercepted.
- Open Hawse.** When the cables of a ship at her moorings lead straight to their respective anchors, without crossing, she is said to ride with an *open hawse*.
- Orlop.** The deck on which the cables are stowed.
- Over-board.** Out of the ship; as, he fell over-board, meaning he fell out of, or from the ship.
- Overgrown Sea,** is expressed of the ocean when the surges and billows rise extremely high.
- Overhaul.** To clear away and disentangle any rope; also to come up with the chase; as *we overhaul her*, that is, we gain ground of her.
- Over-Rake.** When a ship at anchor is exposed to a head-sea, the waves of which break in upon her, the waves are said to *over-rake* her.
- Over-set.** A ship is *over-set* when her keel turns upwards.
- Out-of-trim.** The state of the ship when she is not properly balanced for the purposes of navigation.
- Parcel a rope.** Is to put a quantity of old canvass upon it before the service is put on.
- Parcel a seam.**—is to lay a narrow piece of canvass over it after it is caulked, before it is payed.
- Parliament keel.** The situation of a ship when she is made to stoop a little to one side, so as to clean the upper part of her bottom on the other side. See *Boot-topping*.
- Parting.** Being driven from the anchors, by the breaking of the cable.
- Pawl.** A short bar of wood or iron fixed close to the capstan or windlass of a ship, to prevent those engines from rolling back, or giving way, when they are charged with any great effort.
- To Pawl the capstan.** To fix the pawls so as to prevent the capstan from receding during any pause of heaving.
- To pay.** To daub or cover the surface of any body with pitch, tar, &c. in order to prevent it from the injuries of the weather.
- To pay away or pay out.** To slacken a cable or other rope, so as to let it run out for some particular purpose.

To pay off. To move a ship's head to leeward.

To peck the mizen. To put up the mizen yard perpendicular by the mast.

Peck. To ride a stay peck, is when the cable and the fore-stay form a line. **To ride a short peck,** is when the cable is so much in as to destroy the line formed by the stay-peck. **To ride with the yards a peck,** is to have them topped up by contrary lifts, so as to represent St. Andrew's cross.

Pendant. The long narrow flag worn at the mast-head by all ships of the navy. **Brace Pendants**—are those ropes which secure the brace-blocks to the yard arms, and are in general double, in case of one being shot away, the other may secure the yards in its proper position.

Broad Pendant. A kind of flag terminating in a point used to distinguish the chief of a squadron.

Pitching. The movement of a ship, by which she plunges her head and after part alternately into the hollow of the sea.

Point-blank. The direction of a gun when levelled horizontally.

Points. A number of plated ropes made fast to the sails for the purpose of reefing.

Poop. The highest and aftermost deck of a ship.

Pooping. The shock of a high and heavy sea upon the stern or quarter of a ship, when she screws before the wind in a tempest.

Port. A name given on some occasions to the larboard side of the ship; as, the ship heels to port, top the yards to port, &c.—also, a harbour or haven.

Ports. The holes in the ship's sides from which the guns are fired.

Port the helm. The order to put the helm over to the larboard side.

Port-lan. The gunnel.

Press of Sail. All the sail that a ship can set or carry.

Preventer. An additional rope employed at times to support any other, when the latter suffers an unusual strain, particularly when blowing fresh, or in a gale of wind.

Padding and Dolphin. A large and lesser pad made of ropes, and put round the mast under the lower yards.

Purchase. Any sort of mechanical power employed in raising or moving heavy bodies.

Quarters. The respective stations of the officers and people in time of action. **Quartering,** distributing the men into different places. **Quarter-bid,** the list of the ship's company, with their stations for action noticed.

Quarter-wind, is when the wind blows in from that part of the horizon situated on the quarter of the ship. See *On the quarter*.

Quoil, is a rope or cable laid up round, one falk over another.

To Raise. To elevate any distant object at sea by approaching it; thus, to raise the land is used in opposition to lay the land.

To Rake. To cannonade a ship at the stern or head, so that the balls scour the whole length of the decks.

Range of Cable. A sufficient length of cable drawn upon deck before the anchor is cast loose, to admit of its sinking to the bottom without any check.

Rattines. The small ropes fastened to the shrouds, by which the men go aloft.

Reach. The distance between any two points on the banks of a river wherein the current flows in an uninterrupted course.

Ready about. A command of the boatswain to the crew, and implies that all the hands are to be attentive and at their stations for tacking.

Rear. The last division of a squadron, or the last squadron of a fleet. It is applied likewise to the last ship of a line squadron, or division.

Reef. Part of a sail from one row of eyelet-holes to another. It is applied likewise to a chain of rocks lying near the surface of the water.

Reefing. The operation of reducing a sail by taking in one or more of the reefs.

To Reeve. To pass the end of a rope through any hole, as the channel of a block, the cavity of a thimble, &c.

Rendering. The giving way or yielding to the efforts of some mechanical power. It is used in opposition to jamming or sticking.

Ribs of a ship. A figurative expression for the timbers.

Ride at anchor, is when a ship is held by her anchors and is not driven by wind or tide. **To ride athwart,** is to ride with the ship's side to the tide. **To ride hawse fallen,** is when the water breaks into the hawse in a rough sea.

Rigging. A general name given to all the ropes employed to support the masts, to extend or reduce the sails, or to arrange them to the disposition of the wind.

Righting. Restoring a ship to an upright position, either after she has been laid on a carren, or after she has been pressed down on her side by the wind.

To right the helm is to bring it into midships, after it has been pushed either to starboard or larboard.

Rigging out a boom. The running out a pole at the end of a yard to extend the foot of a sail.

To rig the capstern. To fix the bars in their respective holes.

- Reef.** A place near the land where ships may anchor, but which is not sheltered.
- Ribbands, or Ropebands.** Short flat pieces of plaited rope, having an eye worked at one end; they are used in pairs to tie the upper edges of the square sails to their respective yards.
- Rolling.** The motion by which a ship rocks from side to side like a cradle.
- Rough-Tree.** A name applied to any mast, yard, or boom, placed in merchant ships, as a rail or fence above the vessel's side, from the quarter-deck to the fore-castle.
- Rounding-in.** The pulling upon any rope which passes through one or more blocks in a direction nearly horizontal; as, round in the weather-braces.
- Rounding.** Old ropes fastened on the cable, near the anchor, to keep it from chafing.
- Round-turn.** The situation of the two cables of a ship when moored, after they have been several times crossed by the swinging of the ship.
- Rounding-up.** Similar to rounding-in, except that is applied to ropes and blocks which act in a perpendicular direction.
- To Row.** To move a boat with oars.
- Rousing.** Pulling up a cable or rope without the assistance of tackle.
- Rudder.** The machine by which the ship is steered.
- Rullock.** The niche in a boat's side, in which the oars are used.
- Run.** The aftermost part of a ship's bottom, where it grows extremely narrow as the stern approaches the stern-post. Run is also the distance sailed by a ship; and is likewise used by sailors to imply the agreement to work a single passage from one place to another.
- To run out a warp.** To carry the end of a rope out from a ship, in a boat, and fasten it to some distant object, so that by it the ship may be removed by pulling on it.
- To sag to leeward.** To make considerable lee-way.
- Sailing-trim** is expressed of a ship when in the best state for sailing.
- She sands or sends.** When the ship's head or stern falls deep in the trough of the sea.
- Scanting.** The variation of the wind, by which it becomes unfavourable to a ship's making great progress, as it deviates from being large, and obliges the vessel to steer close hauled, or nearly so.
- Stead.** To go right before the wind; and going in this direction without any sail set is called *spoonting*.
- Scuttling.** Cutting large holes through the bottom or sides of a ship, either to sink her, or to unlade her expeditiously when stranded.
- Sea.** A large wave is so called. Thus, they say a *heavy sea*. It implies likewise the agitation of the ocean, as, a *great sea*. It expresses the direction of the waves, as, a *head sea*. A *long sea* means a uniform and steady motion of long and extensive waves; a *short sea*, on the contrary, is when they run irregularly, broken, and interrupted.
- Sea-boat.** A vessel that bears the sea firmly, without straining her masts, &c.
- Sea-clothes.** Jackets, trowsers, &c.
- Sea-mark.** A point or object on shore conspicuously seen at sea.
- Sea-room.** A sufficient distance from the coast or any dangerous rocks, &c. so that a ship may perform all nautical operations without danger of shipwreck.
- Seize.** To bind or make fast.
- Serve.** To wind something about a rope to prevent it from chafing or fretting. The service is the thing so wound about the rope.
- Setting.** The act of observing the situation of any distant object by the compass.
- To set sail.** To unfurl and expand the sails to the wind, in order to give motion to the ship.
- To set up.** To increase the tension of the shrouds, back-stays, &c. by tackles, haliards, &c.
- Settle.** To lower; as, *settle the topsail haliards*, lower them.
- To settle the land.** To lower in appearance. It is synonymous with *to lay the land*.
- Shank.** The beam or shaft of an anchor.
- Shank-painter.** The rope by which the shank of the anchor is held up to the ship's side; is also made fast to a piece of iron chain, in which the shank of the anchor lodges.
- To shape a course.** To direct or appoint the track of a ship, in order to prosecute a voyage.
- Sheer.** The sheer of the ship is the curve that is between the head and the stern upon her side. *The ship sheers about*, that is, she goes in and out.
- To sheer off.** To remove to a greater distance.
- Sheers,** are spars lashed together and raised up for the purpose of getting out or in a mast.
- Sheet.** A rope fastened to one or both of the lower corners of a sail, in order to extend and retain it in a particular situation. When a ship sails with a side wind, the lower corner of the main and fore-sails are fastened by a tack and a sheet, the former being to windward, and the latter to leeward; the tack is, however, only changed with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets; the stay-sails and studdensails have only one tack and one sheet each, the stay-sail tacks are fastened forward, and the sheets drawn aft, but the

Studdensail tacks draw the outer corner of the sail to the extremity of the boom, while the sheet is employed to extend the inner corner.

To sheet home. To haul the sheets of a sail home to the block on the yard-arm.

To shift the helm. To alter its position from right to left, or from left to right.

To ship. To take any person, goods, or thing on board. It also implies to fix any thing in its proper place, as, to *ship the oars*, to fix them in their rullocks.

Ship-shape. In a seaman like manner, as, that mast is not rigged ship-shape; put her about ship-shape, &c.

Shivering. The state of a sail when fluttering in the wind.

Shoal. Shallow.

Show the anchor. A small block of wood, convex on the back, and having a hole sufficiently large to contain the point of the anchor-fluke on the fore side, it is used to prevent the anchor from tearing the planks on the ship's bow, when ascending or descending.

To shoot a-head. To advance forward.

Shore. A general name for the sea coast of any country.

To shorten sail. Used in opposition to *make sail*.

Shrouds. A range of large ropes extended from the mast heads to the right and left sides of a ship, to support the masts, and enable them to carry sail.

Sinnett. A small plaited rope, made from rope-yarns.

Slack-water. The interval between the flux and reflux of the tide, when no motion is perceptible in the water.

Slack, is applied to the period of a transitory breeze.

To slip the cable. To let it run quite out when there is not time to weigh the anchor.

To stee. To turn any cylindrical piece of timber about its axis without removing it. Thus, to *stee a mast*, or boom, is to turn it in its cap or boom iron. Also to turn any package or cask round.

Sound. To try the depth of water.

Sounding-line. A line to sound with, which is marked in the following manner:—Black leather at 2 and 3 fathoms, white at 5, red at 7, black at 10, white at 13, (some seamen use black at 10 and 13) white at 15 as at 5, red at 17 as at 7, two knots at 10 fathoms, and an additional knot at every ten fathoms, with a single knot midway between each 10 fathoms, to mark the line at every five fathoms.

To spell the Mizzen. To let go the sheet and peek it up.

To spill. To discharge the wind out of the cavity or belly of a sail, when it is drawn up in the brails, in order to furl or reef it.

Spilling lines are ropes contrived to keep the sails from being blown away, when they are closed up in blowing weather.

Splice. To make two ends of ropes fast together by untwisting them, and then putting the strands of one piece with the strands of the other.

Split. The state of a sail rent by the violence of the wind.

Spoon-drift. A sort of showery sprinkling of the sea water swept from the surface of the waves in a tempest, and flying like a vapour before the wind.

Spray. The sprinkling of a sea, driven occasionally from the top of a wave, and not continual as a spoon-drift.

To spring a mast, yard, &c. To crack a mast, yard, &c. by means of straining in blowing weather, so that it is rendered unsafe for use. **To spring a leak.** When a leak first commences, a ship is said to *spring a leak*. **To spring the tuff.** A ship is said to *spring her tuff*, when she yields to the effort of the helm, by taring nearer to the wind than before.

Spring-stays, are rather smaller than the stays, and placed above them, and intended to answer the purpose of the stay, if it should be shot away, &c.

Spring-tides, are the tides at new and full moon, when flow highest and ebb lowest.

Sparling Line, is a line that goes round a small barrel amid the barrel of the wheel, and coming to the front beam of the poop deck, moves the tail-stale with the turning of the wheel, and keeps it always in such position, as to show the position of the tiller.

Star-shoes, are large pieces of timber which come abast the pump well.

Squall. A sudden violent blast of wind.

Square. This term is applied to yards that are very long, as *land is to high masts*.

To square the yards. To brace the yards so as to hang at right angles with the keel.

To stand on. To continue advancing. **To stand in.** To advance towards the shore.

To stand off. To recede from the shore.

Starboard. The right hand side of the ship when looking forward. **Starboard-tack.** A ship is said to be on the *starboard tack* when sailing with the wind blowing upon her starboard side.

Starboard the helm. An order to push the helm to the starboard side.

To stay a ship. To arrange the sails and move the rudder so as to bring the ship's head to the direction of the wind, in order to get her on the other tack.

Stays. Large ropes coming from the mast heads down before the masts, to prevent them from springing, when the ship is sending deep.

Steady! The order to the helmsman to keep the ship in the direction she is going at that instant.

Steering. The art of directing the ship's way by the movement of the helm.

Steering-way. Such degree of progressive motion of a ship as will give effect to the motion of the helm.

Stem. A circular piece of timber, into which the two sides of a ship are united at the fore end; the lower end is scarfed to the keel, and the bowsprit rests on the upper end.

To stem the tide. When a ship is sailing against the tide at such a rate as enables her to overcome its power, she is said to *stem the tide*.

Steeve. Turning up. The bowsprit steeves too much, that is, it is too upright.

Sternfast. A rope confining a ship by her stern to any other ship or wharf.

Sternmost. The furthest astern, opposed to *headmost*.

Sternway. The motion by which a ship falls back with her stern foremost.

Stiff. The condition of a ship when she will carry a great quantity of sail without hazard of oversetting. It is used in opposition to *crank*.

Stoppers. Large kind of ropes, which, being fastened to the cable in different places abaft the bitts, are an additional security to the ship at anchor.

To stow. To arrange and dispose a ship's cargo.

Strand. One of the twists or divisions of which a rope is composed. It also implies the sea beach.

Stranded. This term, speaking of a cable or rope, signifies that one of its strands is broken: applied to a vessel, it means that she has run aground and is lost.

To stream the buoy. To let it fall from the ship's side into the water, previously to casting anchor.

Stretch out. A term used to men in a boat when they should pull strong.

To strike. To lower or let down any thing. Used emphatically to denote the lowering of colours in token of surrender to a victorious enemy.

To strike sounding. To touch ground when endeavouring to find the depth of water.

Sued, or Sewed. When a ship is on shore and the water leaves her, she is said to be sued; if the water leaves her two feet, she *sues*, or is *sued* two feet.

Surf. The swell of the sea that breaks upon shore or on any rock.

To surge the capstern. To slacken the rope heaved round upon it.

Sway away. Hoist.

Swell. The fluctuating motion of the sea either during or after a storm.

Sweeping. The act of dragging the bight or loose part of a rope along the surface of the ground, in a harbour or road, in order to drag up something lost.

Swinging. The act of a ship's turning round her anchor at the change of wind or tide.

To tack. To turn a ship about from one tack to another, by bringing her head to the wind.

Taffarel. The uppermost part of a ship's stern.

Taking in. The act of furling the sails. Used in opposition to *setting*.

Taking a-back. See *a-back*.

Tamkins, or Tomkins. The bung, or piece of wood, by which the mouth of a cannon is filled to keep out wet.

Tarpaulin. A cloth of canvass covered with tar or some other composition, so as to make it water proof.

Taught. Improperly though very generally used for *tight*.

Taunt. High or tall. Particularly applied to masts of extraordinary length.

Tell-tale. An instrument which traverses upon an index in the front of the poop-deck, to show the position of the tiller.

Tending. The turning or swinging of a ship round her anchor in a tide-way at the beginning of ebb and flood.

Thwart. See *a-thwart*. *Thwart ships.* See *a-thwart ships*.

Thus. An order to the helmsman to keep the ship in her present situation, when sailing with a scant wind.

To tide. To work in or out of a river, harbour, or channel, by favour of the tide, and anchoring whenever it becomes adverse.

Tide it up. To go with the tide against the wind.

Tide-way. That part of the river in which the tide ebbs and flows strongly.

Tier. A row; as a tier of guns, a tier of casks, a tier of ships, &c. *Tier of a cable.* A range of the fakes or windings of a cable which are laid within one another, in a horizontal position. *Cable Tier*—the space in the midst of a cable when it is coiled; also the place in which it is coiled.

Tiller. A large piece of wood or beam, put into the head of the rudder, and by means of which the rudder is moved.

Topping. Pulling one of the ends of a yard higher than the other.

Tart or Taut, signifies tight.

To Tow. To draw a ship in the water by a rope, fixed to a boat or other ship which is rowing or sailing on.

Tow-line. A small hawser, or rope, used to remove a ship from one part of a harbour to another.

Transoms. Certain beams or timbers extended across the sternpost of a ship to fortify her after part, and to give it the figure most suitable to the service for which she is calculated.

Traverse. To go backwards and forwards.

Trunnels or Trunnals. Long wooden pins employed to connect the planks of the ship's side and bottom to the corresponding timbers.

Ttry-sail. A small sail used by cutters and brigs in blowing weather.

Trice, trice up. To haul up and fasten.

Trim. The state or disposition by which a ship is best calculated for the purposes of navigation. *To trim the hold*—to arrange the cargo regularly. *To trim the sails*—to dispose the sails in the best arrangement for the course which a ship is steering.

To trip the anchor. To loosen the anchor from the ground, either by design or accident.

Trough of the Sea. The hollow between two waves.

Truck. A round piece of wood put upon the top of flag-staves, with sheaves on each side for the halliards of the flags to reeve in.

Turning to windward. That operation in sailing, whereby a ship endeavours to advance against the wind.

To Unballast. To discharge the ballast out of a ship.

To Unbend. To take the sails off from their yards and stays. To cast loose the anchor from the cable. To untie two ropes.

To Unbit. To remove the turns of a cable from off the bits.

Under foot, is expressed of an anchor that is directly under the ship.

Under sail, or under way. When a ship is sailing she is said to be under way.

Under the lee of the shore, is to be close under the shore which lies to windward of the ship.

Unfurl. Cast loose the gasket of the sail.

To Unmoor. To reduce a ship to the state of riding at single anchor, after she has been moored.

To Unrigger. To draw a rope from out of a block, timber, &c.

To Unrig. To deprive the ship of her rigging.

Urron. The piece of wood by which the legs of the crow-foot are extended.

Van. The foremost division of a fleet in one line. It is likewise applied to the foremost ship of a division.

Vane. A small kind of flag worn at each mast head.

To Veer or Wear the ship. To change a ship's course from one tack to the other, by turning her stern to windward.

Veer. Let out, as veer away the cable.

Veer. Shift. The wind veers, that is, it shifts, changes.

To Veer and Haul. To pull a rope tight by alternately drawing it in and slackening it.

Viol or Foyal. A block through which the messenger passes in weighing the anchor. A large messenger is called a viol.

Wake. The path or track impressed on the water by the ship's passing through it, leaving a smoothness in the sea behind it. A ship is said to come into the wake of another when she follows her in the same track, and is chiefly done in bringing ships to, or in forming the line of battle.

Wales, are strong timbers that go round a ship a little above her water-line.

Warp. A small rope employed occasionally to remove a ship from one place to another.

To Warp. To remove a ship by means of a warp.

Waul. That part of a ship contained between the quarter deck and the fore-castle.

Water line. The line made by the water's edge when a ship has her full proportion of stores, &c. on board.

Water borne. The state of a ship, when there is barely a sufficient depth of water to float her off from the ground.

Water-logged. The state of a ship become heavy and inactive on the sea, from the great quantity of water leaked into her.

Water-tight. The state of a ship when not leaky.

Weather. To weather any thing is to get to windward of it. Synonymous with windward.

Weather-beaten. Shattered by a storm. **Weather-bit**. A turn of the cable about the end of the windlass. **Weather gage**. When a ship or fleet is to windward of another, she is said to have the weather-gage of her. **Weather-quarter**. That quarter of the ship which is on the windward side. **Weather-side**. The side upon which the wind blows.

To Weigh Anchor. To heave up an anchor from the bottom.

To Wind a Ship. To change her position, bringing her head where her stern was.

Wind road. When a ship is at anchor, and the wind being against the tide, is so strong as to overcome its power and keep the ship to leeward of her anchor, she is said to be *wind-road*.

Wind's eye. The point from which the wind blows.

To Windward. Towards that part of the horizon from which the wind blows.

Windward Tide. A tide that sets to windward.

To Work a ship. To direct the movements of a ship by adapting the sails and managing the rudder according to the course the ship has to make.

To work to windward. To make a progress against the direction of the wind.

Woold. To bind round with ropes.

Yards. The spars upon which the sails are spread.

Yawing. The motion of a ship when she deviates from her course to the right or left.



EVOLUTIONS AT SEA.

Of the Ballast and Lading.

WHEN a ship is loading, it should be considered that her tendency to pitch or roll depends not alone on her form, but even more upon the distribution of the heaviest parts of her cargo.

Particular attention is to be paid to moderate her pitching, as that is what most fatigues a ship and her masts : and it is mostly in one of these motions that masts are seen to break, particularly when the head rises after having pitched. Although the rolling be proportionably a more considerable movement than pitching, it is seldom any accident is seen to arise from it, as it is always a slow one. It is however not less proper to prevent it as much as possible. This will, in general, be easily obtained, without being any way detrimental to the ship's stiff carrying of sail, if, when the ballast is iron, you stow it up to the floor heads ; because it will recall the ship with less violence after her having inclined, and it will act on a point but little distant from the centre of gravity.

In the merchant service the stowage consists, besides the ballast, of casks, cases, bales, boxes, &c. which are all carefully wedged off from the bottom, sides, pumpwell, &c. and great attention paid that the most weighty materials are stowed nearest to the centre of gravity, or bearing of the ship, and higher or lower in the hold, agreeable to the form of the vessel. A full low built vessel requires them to be stowed high up, that the centre of gravity may be raised, to keep her from rolling away her masts, and from being too stiff and laboursome ; as, on the contrary, a narrow, high built vessel requires the most weighty materials to be stowed low down, nearest the keelson, that the centre of gravity may be kept low, to enable her to carry sail, and to prevent her oversetting.

To anchor in fine weather in a place where you will ride head to wind, being close hauled.

Being under the three topsails, fore-topmast stay sail, and mizen, stand on until you are within about two ship's lengths of the place where you mean to drop your anchor ; then put the helm a-lee, and haul down the fore-topmast stay sail. As soon as the topsails shiver, clue them up briskly, before you lower, except the mizen topsail, which is to be laid to the mast, and the mizen sheet hauled flat aft, the instant the ship begins to have stern way, by reason of the wind being a-head. Then shift the helm to windward, and let go the anchor, veering away the cable, to give it time to settle in the ground, until the vessel falls off, when she is to be checked, to bring her head to the wind. When that is done, right the helm, and haul up the mizen.

To anchor in fine weather in a place where you will ride head to wind, the wind being large.

If you have the wind large, whether on the beam or more aft, the operation is still the same, only hauling up a little sooner to keep to windward, because it is in your power to drift as much as you think requisite, and because the ship will be entirely stopped as soon as all her sails begin to catch a-back, and you will have done cluing them up when they begin to shake. The mizen topsail is next to be heaved to the mast, the helm put a-weather, and the anchor let go, as soon as the head-way ceases ; then after giving her a sufficiency of cable, bring the ship up. If she has been going large she will not range precisely head to wind, since her headway ceases as soon as the sails are taken a-back, and the effort of the wind acts on all the rigging of the ship to impel her

both a stern and to leeward, which is indeed augmenting the effect of the rudder, as the helm is a-weather to bring the vessel to the wind; but as the power of the wind is very great to pay the ship's head off, it balances, wholly or partly, (according as the ship goes a stern with more or less velocity,) the effort of the rudder and that of the mizen: thus she drifts, and remains as it were lying to with all her sails aback. This is the reason why we keep a little to windward, and let go the anchor, to bring the ship's head to wind at the proper time, which she will do the more readily as she is withheld forward by the cable, while the wind on her side forces her to leeward.

To anchor in fine weather in a place where you are to ride head to the stream and wind, the wind being large.

If you are obliged to ride with the head to the stream, you must, when it comes from the windward, put the helm a-lee in setting the mizen, then clue up the sails: and when the ship's head is right in the direction of the stream, let go the anchor, provided she has quite lost her headway; for else, you would get foul of the anchor stock by running over it. This must never be neglected, unless you find yourself under the necessity to bring up in any situation in which you may happen to be, which is almost always the case when you are taken too short to have time to stop the vessel: a reason why there is often a necessity of casting a second anchor, which generally catches the ground by assistance of the first, which has begun to diminish the velocity of the ship; and as many of the sails are to be hauled down as you can, and as quick as possible.

To anchor in fine weather in a place where you will ride head to the stream, which comes from leeward, the wind being large.

When the current comes from the leeward, you must keep the ship away till her head comes to the set of the stream, and take in all the sails to diminish as speedily as possible her headway, which always continues of itself long enough when the wind is aft or very large, and when the ship is stopped by the effort of the water, let go the anchor without waiting for the vessel gathering stern-way, if the current is rapid; and in this case, as well as all those wherein there is a sea, or blowing fresh, the ship requires a great length of cable.

To come to an anchor with the wind aft.

First, haul the main topsail, and then lower the fore topsail down on the cap, and when you are within a reasonable distance of the place where you mean to drop anchor, (which distance is to be judged of from the readiness of the ship to obey the helm, and from her velocity) the tiller may be put either one way or the other, the fore topsail and fore topmast stay sail clued up and taken in, the mizen topsail braced sharp up, and the mizen sheet hauled flat aft. When the ship ranges close to the wind, she is, as it were, lying to under the mizen and mizen topsails, with the last mentioned sail full or a-bulk according as you may have occasion to shoot a-head or drop a-stern; so that if you are too much to windward of the spot where you mean to bring to, you drift till you arrive at it: if you are precisely in the proper birth, you let go the anchor in lowering down the mizen topsail, which is to be furled as soon as the vessel is brought up; then the ship will come head to wind by the power of the mizen, which must be bralled up as soon as it shakes.

Scudding under a foresail, to come to an anchor.

The foresail must be clued up when at some distance from your birth; and, some part of the way, run under bare poles. When near enough to sheer to the wind, you execute it by putting the helm hard a-lee; and as soon as the ship is come to, let go the anchor, giving her a large scope of cable, and observing to check her handsomely, in order to make her ride head to wind, as stopping her at first too short might endanger her cable or anchor. Should the first not bring her up, a second may be let go.

To anchor with a spring, in order to present the vessel's side to a place or ship you wish to cannonade.

This is executed when you know that the wind or current will bring your head, when a anchor, towards the object you mean to attack; for should the wind or tide bring your bow-side to bear on the object you mean to cannonade, the spring would only be a precaution to get under way more quickly in case you were obliged to retreat, or in case the wind or tide should shift.

Get a large snatch-block in the aftermost port, or on the same side you wish to present to the wind or current, and on the same side with the anchor and cable with which you mean to bring up; then, through the block reeve a hawser, the end of which is to be clinched in the ring of the anchor you mean to let go, the other part is to be brought to the capstan with necessary ranges of the cable and hawser on deck. That

done, and the ship being arrived at the birth, you are to deaden her way according to circumstances ; then let go the anchor, and veer away enough cable and hawser, now a little more of the one, and then a little more of the other, according as you wish to present more head or stern ; which you can do by heaving on the spring, or what is the same, veering away more cable. Should you find it requisite to shift your position, you have only to veer out more of the hawser.

To come to anchor in roads that are often crowded with ships, and to leave clear births for others.

The best anchoring births in these places are mostly known by marks, and of course are occupied by the first ships.

In a tide or trade wind road-stead, the next ship that comes should not anchor right ahead or a-stern of the first ship and so as to lie in the other's hawse, but should come to on the bow and quarter at a sufficient distance to prevent other ships from coming between, and in a slanting direction from the tide or wind. This might contribute to the safety of ships when it blows strong upon a lee-tide or in strong sea breezes, as each single ship may then veer away what cable necessary, and keep clear of the other ship's hawse a-stern ; or, in case of driving or casting, they have a better chance of keeping clear of each other.

To get up an anchor, in ships which have a main and jeer capstan.

In large ships which have a main and jeer capstan, and the strain is thought too great for the messenger alone, the viol is used thus : Three or four turns are taken round the jeer-capstan with one end, so as to leave that side clear on which the cable is coming in ; and pass the other end through the viol block, which is lashed round the main-mast on the lower deck. It is then carried forward and passed round the rollers in the manger near the hawse holes ; then brought aft, and spliced to the other end with a short splice, and the ends marled down tight. That side of the viol on which the cable is coming in is fastened to the cable by nippers ; and thus the continued efforts of the capstan are conveyed to the cable, until it is hove in. The nippers are clapt on in the manger, from one to two fathoms asunder ; and the viol is applied to the midships, or inside of the cable. Nippers are clapt on by taking three or four turns round the viol, four turns round the cable and viol, and then three or four turns round the cable. This method is an exceeding good one, and very suitable to quick heaving ; but when the strain is great, and the cable muddy, the nippers clapt on after this method will not nip sufficiently, and some times recourse is had to the following method : Throw sand or ashes upon the cable, and take a long dry nipper, which middle and pass one half aft, racking it in and out round the cable and viol ; then worm its end round the viol only. After this pass the other half in the same manner forward, but worm its end round the cable only, and let each end of the nipper be held on. The advantages of this method are, that as the strain of the cable lies forward and that of the viol aft, the nipper will be drawn so tight as effectually to hold the cable till something gives way : also they can never jamb, for both ends are clear for taking off. Another method, when the strain is great, is, to have nippers with an overhand knot made at one end ; and with that end a round turn taken round the cable and viol, leaving three or four feet of the end ; then with the other end, take three or four racking turns, and expend nearly the remainder with turns round the cable and viol, laying the knotted end under and over each of the last turns ; the end is then held fast. The men who clap on the nippers are attended by boys, who hold the ends of them, and follow the progress of the cable as it is hove in ; and, as the nippers arrive near the main hatch-way, they are taken off and carried forward, where they are again clapt on, and so in succession until the cable is hove in sufficiently to raise the anchor above the water. It is then stoppered round all before the bitts, that is, round the cable and viol. The anchor is then catted, and afterwards fished. To shift the viol for heaving in a second anchor, it must be unspliced, and the turns round the capstan reversed. When the strain is so great as to require other purchases, the top tackles may be used thus : the double block is lashed to the main-mast or topsail-sheet bitts, the treble block is lashed on the cable, and the fall is brought to the capstan. If the top tackle falls are thought insufficient, any hawser may be used that will reeve through the blocks.

To get up an anchor in ships which have not a jeer-capstan.

Ships without a jeer-capstan have no viol, but heave in their cables by a messenger, which has an eye spliced in each end, one of which ends is passed with three or four turns round the capstan on the upper deck, and the other end passed forwards round the rollers, at the fore part of the manger ; then brought aft to the other end, and lashed thus : several turns are passed through the eyes crossing each other in the middle, then a half hitch is taken round the parts, and the end stoppered with spun-yarn. The remainder of the operation is performed as by the viol, with this exception ; the ~~messenger~~

senger is applied to the outside of the cable, and when the nippers are insufficient, the messenger may be hitched thus : the bight of the messenger is fastened round the cable at the manger with a rolling hitch, and the bight seized round the cable before the hitch. This practice is by no means so good as the others.

When getting under way in a sea gale, the viol is better than a messenger, as the sending of the ship carries all the strain to the main capstan, and endangers the men at the bars, whereas with a viol, the strain is taken to the viol block, and the men at the fore-jeer-capstan heave in security.

To get up a second anchor.

Suppose by the former methods, that the starboard anchor is got up, and that the cable of the second anchor enters the larboard hawse-hole, the operation of getting up the second anchor is the same, observing only, that the messenger must be shifted, and the turns on the capstan reversed, to change the disposition and side ; and the men, who before held on the larboard side in the first operation, will hold on the starboard side now. The motion of the capstan is performed the contrary way, and the cable on the larboard side is fixed and hove in.

To get up an anchor in Merchant Ships.

Most merchant ships and small vessels heave up their anchors by a windlass, round which are taken three turns of the cable, and held on by hand, or by a jigger ; thus—the end of the rope which has the sheave is passed round the cable, with a round turn, close to the windlass, the leading part of the rope coming over the sheave, and stretched aft, by means of the fall passing through the jigger block ; the standing part of the fall is made fast round a stantion, at the fore part of the quarter deck, and the leading part is bowed upon, which jams the turns taken round the cable, and, when the jigger arrives abreast of the hatchway, it is removed forward, and the cable is jammed by a handspike at the windlass, until the jigger is refixed.

To weigh an anchor with the long boat.

This is done by taking the long boat to the buoy of the anchor, and putting the buoy-rope over the davit of the long boat, and a tackle on the buoy-rope ; by which, with the assistance of men on the fall, the anchor is weighed out of the ground. This being accomplished, the cable is hove in on board ; the buoy-rope and tackle being secured in the boat, they approach the ship, as the cable is hove in, and the anchor catted and stowed. Small anchors and grapnels are got up by the davit, hauling upon the grapnel rope by hand.

To weigh an anchor by under-running.

This is by placing the cable over the davit-head, and under-running it, till it is nearly apeak, when it is tripped by means of tackles, as before by the buoy-rope. This method is troublesome, and is only adopted when the buoy is gone, and a ship cannot get near her anchor for want of water.

To get under sail when the ship is swinging head to wind, and you want to cast either to starboard or larboard, in a place where there is no current.

To cast to starboard.

Heave short on your anchor till it is apeak ; then haul in quite home, the larboard braces forward, and starboard braces abaft ; loosen, sheet home, and hoist the topsails ; put the helm a starboard, and heave till the anchor is aweigh. The moment the anchor quits the ground, the ship will begin to fall off to starboard. As soon as this movement is perceived, hoist the jib and fore-topmast staysail, if necessary, to help her ; and when she has sufficiently fallen off, her sails abaft (which are trimmed sharp for the larboard tack) will fill. But, unless for very superior reasons, you had better continue lying-to till the anchor is catted, taking care to haul the mizen-sheet close aft, if the ship be inclined to fall off too much.

To cast to larboard.

Haul in the starboard braces forward and the larboard aft, and put the helm a-port. The rest of the operation is the same as the preceding, only changing the starboard for port.

To get under sail when the ship is riding head to wind and tide.

If a ship, riding head to wind and tide, wanted to get under sail, after having decided on which side it is best to have her cast, it must be performed according to one of the foregoing methods, except with regard to the helm, which must be put to starboard either before the anchor loosens, or while it does, if you wish to cast to port ; because the water coming from forward, acts with the same force on the rudder as if the ship went with the current, impelling the rudder to starboard and head to port. Therefore it is evident in this case, the helm ought to be put to starboard ; which, on the contrary, would be put to larboard, if the ship were to be cast to port.

If the ship, after the anchor is out of the ground, goes astern faster than the current runs, the helm must then be used as if there was no current, because the excess of velocity, whereby the ship exceeds that of the water, acts upon the rudder.

If it blows fresh, so that you cannot set your topsails without reefing them, let that be done before they are sheeted home; and if it blows so hard as to be obliged to go only under a foresail, it would then be sufficient to loosen the fore-topsail, without sheeting it home, after having braced it quite close on the side opposite to that you want the ship to cast, not forgetting however to put the helm the same way as you cast, as soon as you perceive the ship going astern: and when the ship has fallen off sufficiently, then is the time to fill and trim the foresail.

To get under sail when the ship is swinging with her head to the current, and with the wind a point abaft the beam.

Heave short on your anchor till it is a-peek; next to this loosen, sheet home, and hoist the foresail and mizen-topsail, keeping the wind in, and heave vigorously at the capstan, till the anchor is a-weigh. At the same time hoist the jib and fore-topmast staysail, or haul out the mizen, according as circumstances may require. Whether you wish to come to windward, or fall off more quickly, you must still continue to heave round the capstan briskly, to get the anchor up, till you find yourself sufficiently off-ward to bring to, in order to stow it with ease, or to stand on under an easy sail with the anchor hanging out to windward, if the situation of things will admit of it. You may sometimes also hoist up both the main and fore-topsails, as soon as you get ready; but in certain cases, as when obliged to make the best of your way from an enemy, every sail possible must be set at once which the weather will admit of, especially when obliged to haul by the wind; in which case, the anchor must be got up and catted as well as it can; there are cases even when, without losing your time in weighing it, you crowd as many sails as you possibly can, and depart, in cutting or slipping the cable.

To get under sail with a spring.

If a ship be in a place too confined to cast under her sails only, or being obliged to put to sea in a gale of wind, without hoisting the anchors, you must, for greater safety, in casting the right way, get a spring out, to be clapped on the cable by which the ship swings, by passing a hawser or a stream cable through the aftermost port, on the opposite side to that you mean to cast; and after that spring is well hove tight at the capstan, hoist the jib and fore-topmast-staysail, loose and sheet home the fore-topsail; when that is done, and if the weather permits, brace quite close the head sails, on the same side with the spring. When this is executed, slip or cut the cable, heaving briskly at the same time on the spring, till the ship has paid off sufficiently. Then fill the sails, by setting the mizen-topsail and every other sail you mean to employ, and slip or cut the spring, as circumstances may require. Care must be taken, not to let the ship fall off too much, before the spring is cut; because, having no way through the water, she will not come to the wind so soon as might be wished; and for the same reason the spring must not be cut, till she has fallen off as much as is necessary; because, although she has no other motion but that of falling off, the vessel might perhaps not wear enough to answer the purpose.

To get under sail with a leading wind, in a tide way.

If the ship to be got under sail has a leading wind, and is in the midst of vessels, or in a narrow channel, where it would be difficult to cast her upon the lee-tide, she should be got under sail before the weather-tide is done. Thus, the casting of the ship would be avoided, and she may be steered through the fleet or channel with safety.

Should it, however, blow so fresh upon the windward-tide as to force the ship end on with her cable, it will be impossible to heave it in, without sheering the ship over from side to side, and heaving in briskly as the ship slacks the cable; but as this is attended with much danger, by the ship suddenly bringing up upon each sheer, it will be best to heave a-peck upon the first setting of the windward tide, before the ship swings to bring the wind abaft.

To cast a ship upon the larboard tack, and back her a-stern of danger.

We suppose the ship to lie at single anchor, with the wind and tide the same way, and ships or shoals right astern, in the intended course, and that to clear them, you must cast upon the larboard tack, and make a stern board.

Make every thing as ready as possible before weighing: let the three topsails be hoisted, the yards braced up sharp with the larboard braces, and the mizen hauled out. Thus situated, when the anchor weighs, put the helm a-port. The tide, running aft, acts upon the starboard side of the rudder; and in that direction it will cast the ship the right way, and bring the wind upon the larboard bow. The wind being on the larboard bow, and the topsails a-back, will soon give the ship stern-way through the water; then the water will act against the larboard side of the rudder, and powerfully prevent

the ship is before the wind, get on board the main-tack, and right the helm to moderate her coming to.

If, in the beginning, the ship is found difficult to veer, the fore stay-sail may be hoisted, and the sheets hauled well aft ; but it is to be hauled down as soon as the ship is before the wind.

A second method.

Make fast a four inch rope to the strings of the main yard ; and when the ship comes-to, so as to shiver the main sail, bring it down before the sail to the topsail sheet bitts, and let it be hauled tight and belayed. Then, as soon as she falls off, put the helm a-weather, and let go the main sheet. By these means, the lee part of the sail no longer has any power to keep the ship to the wind, and the weather part, acting before the centre of gravity, will cause her to veer faster than by the first method ; though, in general the first method will answer the purpose.

To veer under bare poles.

The fore-staysail must, if circumstances will allow it, be hoisted. But if that cannot be done, the head yards are to be braced up as sharp as possible, and those abaft pointed to the wind. Then, if the ship veers, she will steer under the masts and ropes only. A number of seamen sent up and placed close to each other in the weather fore-shrouds will be found also of very great service.

To box-haul a ship, or the second method of veering.

In this evolution the most rapid execution is necessary. Briskly, and at the same instant, haul up both the mainsail and the mizen ; shiver the main and mizen topsails ; put the helm hard a-lee ; raise the fore tack ; let go the head bowlines, and brace about the head yards sharp the other way ; and let the jib and staysail sheets go in the same instant. When the ship has fallen off 90°, brace the after yards square in order to give the ship a little way, and to help her (with the rudder, the situation of which must be changed) to double the point where all the sails shiver ; and when the wind is aft, you will proceed as in the method of "veering without losing the wind out of the sails."

If the circular motion of the ship, after she has fallen off 90°, continues pretty rapid, the filling of the after sails, to give the ship headway, may be dispensed with ; because she continues to turn by the effect of her helm, which must not be shifted, since the vessel still continues her stern-way. Therefore, after having veered a few degrees more, the wind will fill all her sails, and the ship consequently will have head way. Then change the situation of the rudder to bring her before the wind.

In a case of absolute danger, when it might be necessary to go a-stern and fall off more rapidly, put the helm a-lee, brace all the sails a-back, and observing not to brace the after sails more than square, that they may not counteract the head sails, which are braced sharp a-back to pay the ship's head off ; because the effect of the after sails, in this situation, is to impel the ship abaft in the direction of her keel, which, with those forward, contribute to give her fresh stern-way. in order to cause the ship to veer with greater celerity. The jib and fore-topmast-staysail sheets being hauled over to windward, will assist the ship in falling off and going astern.

Box-hauling is deemed the surest and readiest way to get a ship under command of the helm and sails, with the least loss of ground to leeward, when a ship refuses stays. The masters of sloop rigged vessels, turning to windward in narrow channels, when they want but little to weather a certain point run up in the wind till the head-way ceases, then they fill again upon the same tack ; this they call making a *half-board*. Thus a ship in box-hauling may be said to make two half-boards, first running with her head, then with her stern, up in the wind ; by which two motions a ship rather gains to windward.

To club-haul a ship.

Club-hauling is practised when it is expected that a ship will refuse stays upon a lee-shore : place the hands to their stations for putting the ship about, and some by the lee anchor ; then put the helm down, and if the ship make a stand before she brings the wind a-head, let go the anchor and haul the mainsail. When the wind is a-head, cut the cable, and the ship will cast the way required. The after sails being full, let go and haul.

Another method.

Bend a hawser to the kedge-anchor on the lee-bow, and bring the end into one of the after ports, or over the taffarel. Let go the anchor, brace up all sharp the contrary way, put the helm a-lee, and haul in briskly on the hawser. As soon as the ship gets head-way, cut or slip the hawser, and carry a press of sail.

To lie-to to windward of a ship, so as not to drift near her.

The main-topsail must be braced sharp a-back ; keeping the fore and mizen topsails full ; because the wind acts with a very small sine of incidence on a sail when full, in comparison to what it does when braced sharp a-back ; so that the fore-topsail, being full, draws the ship a head, and the effect of falling off is opposed by the main and mizen-topsails. She will of course not fall off much ; nor will her lee-way be very considerable ; for the ship is well kept to the wind by the disposition given to her sails.

To lie-to under the lee of another ship.

The fore-topsail ought to be braced sharp a-back, the main and mizen topsails kept full, because these two last mentioned sails tend to give the ship head-way, and keep her to the wind ; they may be assisted by the mizen, which will oppose the falling off occasioned by the fore-topsail. Thus, should the ship to windward fall off violently, or drift too much, you are more ready to veer short round, and avoid being boarded ; because the fore-topsail being braced sharp a back, the impulse of the wind on it is much greater than if it were full : and it is well disposed to veer suddenly, as soon as the power of the other sails is suppressed.

To bring-to with the fore or main topsails a-back to the mast or filled.

Either the fore or main-topsail must be braced sharp a-back, and the lee-bowline hauled up a little ; the other two topsails trimmed sharp, with the mizen hauled out, and the helm a-lee.

If you bring-to with the fore-topsail to the mast, the head yards may be only laid square. Then the wind will act obliquely on the sail, and the ship will fall off but little, because the effect is in the direction of the keel from forward aft, and the sails abast, keep the ship to. The main-topsail may be worked in the same manner, if you wish not to expose yourself much to the wind.

To bring-to with the three topsails a-back.

The jib and staysails being hauled down, brace sharp round at once all the sails you wish to lie a-back in hauling up the lee-bowlines, the better to expose the sails to the action of the wind ; haul out the mizen, and put the helm hard a-weather.

To fill when lying-to with the fore-topsail to the mast.

Brail up the mizen, hoist the jib and foretopmast-staysail, shiver the main and mizen topsails, and when the ship has fallen off 20° or 30° , fill the fore-topsail, which was a-back before, and stand on.

To fill when lying-to with the main-topsail to the mast.

Brace sharp and briskly the fore-topsail a-back ; shiver the main and mizen topsails ; hoist the jib and fore-topmast staysails, and brail up the mizen, all at the same time ; and when the ship has fallen off 20° or 30° , fill the fore-topsail and stand on.

If you are obliged to keep the wind on the same tack as that on which you are lying-to, you have only to right the helm, fill the topsail which is a-back, and trim it sharp, to continue your course.

A second method.

Trim the topsail which was to the mast, in order to give the ship way through the water, and be able to tack or run large, according as may be found necessary. But this method is very tedious, unless you mean to heave in stays ; in which case it will be most expeditious.

A third method.

Shiver the main and mizen topsails, keeping the fore-topsail full, righting the helm, and running up the jib and fore-topmast staysail at the same time. As soon as the ship has fallen off enough to get headway, fill the after sails, and keep the ship in the direction you mean to follow. It is easily seen that this method, though the most common, is not the most expeditious, when you have to veer considerably.

To fill when lying to with all the sails to the mast.

Brail up the mizen, lay the after yards square, and shift the helm a-lee. When the ship has fallen off sufficiently to fill the after sails, those forward are then to be braced about and trimmed full also, in order to stand on.

Of lying-to in a gale of wind.

To lie-to when it blows hard, keep as close to the wind as possible under some one sail well trimmed, with the helm lashed a-lee as much as may be requisite for the ship ; and as ships commonly bring-to from the stress of contrary winds, care should be taken to heave-to under such sail as will least strain the ship ; because there are some ships

which lie-to better under the foresail than mainsail, others are more easy under the mainsail, some under a mizen, and many vessels lie-to best under a main staysail.

Lying-to under a foresail.

This is advantageous for veering when you are well to windward; but it engenders the lee-way, and is more subject to break the sea on board, on account of the ship's continual falling off, because in that movement she gathers way by yielding to the impulse of the gale, and is afterwards recalled to the wind by the helm; so that in springing the luff she meets the wave which comes from to windward.

Lying-to under the mainsail.

The ship does not in this situation fall off so easily as in the last mentioned mode, because its effect passes abaft the centre of gravity of the ship; but it keeps the ship more to the wind, and consequently occasions less lee-way.

Lying-to under the mizen.

Under the mizen, ships keep better to the wind than under any other sail, because it is farther abaft the centre of gravity than any of the rest, consequently ought to keep the vessel from drifting more than any of the others; but it is inconvenient should you have occasion to veer suddenly.

Lying-to under the main staysail.

Under the main staysail a ship will not make so much lee-way as under a foresail, because its efforts pass very near the centre of gravity; but it will, however, cause her to drift more than the mainsail; so that this mode of lying-to is a mean between the two others, and is preferable when it blows strong enough for that sail to support the rolling of the ship. It ought likewise to be preferred, because the ship will veer under that sail, the action of which passes at a small distance from the centre of gravity, and the power of the sail overcomes the resistance which all ships meet from the fluid under their lee; a resistance which always gives them a great inclination to fly up in the wind when it blows hard, or when under a heavy press of sail.

Lying-to under the fore, main, and mizen staysails.

All the preceding modes of lying-to have their peculiar faults; but the preferable way is under the fore staysail, the main staysail, and mizen staysail; because under these sails the ship will steer, and is in a better situation for veering than under any other sail; for only haul down the mizen staysail and put the helm a-weather, when the two other sails, being before the centre of gravity, will cause her to fall off; she will then soon gather way, and steer easily.

Should the gale continue very hard, and one of those staysails be blown away, the loss is not of much consequence, as the courses, in case of an emergency, are ready to set; whereas the courses are not so readily replaced when lost. This mode therefore appears preferable in every respect,* whether you wish to veer or keep your wind; because if the ship does not sufficiently keep the wind, you may haul out the balanced mizen, or take in the fore-staysail, or even the main-stay sail. One of these staysails, before the centre of gravity of the ship, is sufficient to make her veer as soon as the after ones are suppressed. There are besides, these following considerations for so doing: the ship will carry sail better; because, as the centre of effort of those on her is very low; she drifts less, holds a better wind, and goes faster through the water; and these three or four sails are so situated as to give the whole body of the ship play, which will strain her less than when under one single sail, which cannot by itself work it from aft forward.

Of sounding in fair weather, whether close-hauled, or going large.

Close-hauled.

If close-hauled, brail up the mizen and mizen-staysail, let go the main sheet that the sail may shiver, put the helm a-lee, and back the mizen-topsail by bracing it square. The head-sails as well as the jib and staysails, are to be kept in their first situation; recollecting to haul tight and belay the lee braces. When the ship has nearly lost her headway, though continuing still to come to the wind, yet catch that moment to heave the lead, and it is to be hauled in again with all possible despatch. To fill again, haul aft the main-sheet, trim the mizen topsail, and right the helm.

Going large.

In going large you have only to put the helm a-lee, to brail up the mizen, and belay the lee braces quite tight, to prevent the yards having too much play when the sails are

* Should the sea run too high for the lower staysails to keep the ship steady, a close-reefed mainsail will be found to answer the purpose admirably.

shivering. It is impossible to tack in this situation, as the jib and head-sails are always in action: and the square-sails soon coming to shake, on account of their sheets not being tacked, they lose all their power, and the ship is soon at a stand.

Another method preferable to the former.

Going large.

Brace the headsails square, haul down the jib and staysails, without stirring the after sails, and put the helm a-lee. While the ship has still a little headway, heave the lead from the place where you haul it in: that lead will go first a little a-stern, but the ship being head to wind, will soon herself go a stern right upon the line, and as the helm is a-lee, the ship easily veers. But, if you wish to keep her to longer, right the helm and haul the mizen out to prevent the ship's falling off.

If you have studding sails set, they must be hauled down, particularly the lower ones, because, should the wind take them aback their power on the boom might bring the ship round entirely for they act on a lever without the ship, the fulcrum of which is on the outside of the vessel before the centre of gravity. If, however, the helm is continued a-lee till the ship falls off, she will not come about, because then the vessel goes a-stern with great velocity, and the rudder acts powerfully to make her veer, but the fact is, that the ship will go a great deal a-stern, and will continue to do so much longer.

Close-hauled.

If close hauled, or a very little from the wind, the helm is to be put a lee, and the instant the sails are taken a-back the headsails are to be filled by briskly bracing them square, without waiting for the wind being right a head, then a little before the ship has lost her way, heave the lead from the place where you haul it in, and then proceed as before.

On ship's driving.

When it happens that there is not sufficient room to work in a tide's way through a crowd of ships, or in a narrow channel, but that the ship must drive by the help of the tide, it may be done, provided the tide be strong enough in proportion to the wind. This art consists in keeping the ship in a fair way, by a management of the rudder and the sails.

To drive to windward, when the wind is against the tide.

If the channel is sufficiently broad, the ship should be drifted broadside to the wind, as the tide will then have the greatest power on her: and could the ship be backed a-stern or shot a-head at pleasure she might be kept drifting upon the same tack with safety, but ships in a tide's way can never be backed so far a-stern as they will shoot a-head. At the first of a stern board, a ship will go briskly a stern, but will soon fall off, and drift with the wind abast the beam, forging a-head, for this reason she must be drifted with the helm a-lee. It follows, as a ship will shoot more a-head than she can be backed a-stern, that she will at length arrive at the opposite shore, when she must be stayed or veered and drifted upon the other tack. If she is to be stayed, (which is preferable, because less drift will be lost by it) let the sails be filled in time to give the ship sufficient headway to bring her about, then put the helm a-lee. Should she come about, the sails and helm having now a proper position for a sternboard upon the other tack, need not be touched till her sternway ceases, when the helm must be shifted a-lee: but should the ship refuse stays, then brace sharp round the headyards, and boxhaul her, by which method she will lose much less drift than by veering.

If the ship now drifting broadside, is approaching a narrow channel, where drifting in this position, she must be veered and dropped, stemming the tide stern foremost. In this case, that the drift may be as much as possible, it will be necessary to take in sail, and reduce the ship's headway till she has only steerage way left, thus a vessel may be dropped through a fleet of ships at anchor without danger.

To drive when the wind is across the tide.

Should the wind be a little across the tide, a ship may be easily drifted in the fair way, with her head towards the weather shore: for thus it will be found that she can be backed and filled at pleasure, and generally be drifted with the sails shivering in which position they oppose least power to prevent the drift.

It frequently happens, in serpentine rivers, that the tide sets across, in this case the ship must be drifted with her head to the side from which the tide sets. These sets are best discovered by observing the opening or shutting of two objects in the direction of the channel.

To bend a course in fair weather.

Stretch the sail a-thwart the deck, the starboard side of the sail to the starboard side,

the larboard to the larboard side ; then bend yard-ropes to the ear-ring cringles, and make fast the head ear-rings a few feet up upon the yard-ropes. The bunt-lines, lee-line, and lee-line leg, that the men may be enabled to catch the head of the sail from the yard. Now man well the yard ropes, bunt-lines, lee-lines, and clue-garnets, and run the sail up to the yard. The sail aloft, send the hands up to bring it to, and let them haul out the weather ear-ring first, then the lee ; and, if it is a new sail, let them ride the head-rope to stretch it. The sail being hauled square out upon the yard, make fast the rope-bands, keeping the head of the sail well upon the yard.

To bend a topsail in fair weather.

Overhaul the leeches of the sail, put in the ear-rings, bend the bow-line legs, lay out the clues, and open them if necessary, and make the sail up snug again ; then round down upon the lee-topsail-haliards till the weather fly-block is high enough to bring the sail up over the guard-iron : then rack the tie over the weather rigging. Now pile the sail upon slings, with the lee-side uppermost : hook on the topsail haliards, and run the topsail up into the top : then stretch the sail round the fore-part of the top, bend the jeer, and make fast the head ear-rings a few feet up upon the reef-tackle-pendants, with a rope-band or two to each bunt-line leg. The jeer being bent, man the reef-tackles, bunt-lines and clue-lines, and haul out the sail. Now let the hands lay out upon the yard, and haul out the weather ear-rings first ; then haul out to leeward, and ease off to windward till the sail is square, when make fast the rope-bands, keeping the head of the sail well up upon the yard.

To set a main-tail or foresail.

Before the sail is loosed, let the double block of a tackle be made fast to the weather-clue, and the single block be hooked low down upon the chess-tree, and the fall led aft. Then man well the tack and fall at the same time ; and when the sail is loosed, ease away the weather-clue-garnet. let go the bunt-lines and lee-lines, bowse down upon the tackle, and take in the main-tack ; the main-tack being down, haul aft the sheet, brace up the yard, and haul the main-bowline.

To set a topsail.

Let a tackle be in readiness to clap on either sheet, as may be required. First man the lee-sheet ; and, the sail being loosed, ease down the bunt-lines and lee clue-line, and haul home the lee sheet ; then haul home the weather sheet, hoist the sail, and brace up as required.

Should the wind be quartering, the lower and topsail yards should be braced well into the wind, before the sail is sheeted home.

To take in a course.

Man well the weather clue-garnet, ease off the tack and bowline, and run it up ; then, man the lee clue-garnet, bunt-lines, lee-lines, and weather braces ; and being all ready, ease away the sheet, haul up the clue-garnet, bunt-lines, and lee-lines, and round in the weather-brace, till the yard is pointed to the wind. Then haul tight the trusses, braces, lifts and rolling tackle, and let the hands furl the sail.

To take in the foresail in the time of veering.

When the ship begins to veer, the yard being kept braced sharp up, let go the tack and bowline, and haul up the weather clue-garnet. When the ship is nearly before the wind, the bunt and lee-lines, and the other clue-garnet may be hauled up ; and if the situation admits of it, and occasion requires, the ship may be steered with the wind on the quarter, till the sail is secured.

To take in a topsail.

There are many opinions upon the best mode of performing this. Some approve of cluing up to windward first, and others to leeward. If the weather-side is to be clued up first, the weather brace must be rounded well in, and the yard got close down upon the lifts, otherwise the lee rigging will be in danger of being carried away by the great pressure of the lee yard-arm. If the weather brace can be rounded well in, and the yard be got close down, it will be best to clue up to windward first, for thus the sail may be taken in without a shake, but, if the weather-brace cannot be hauled in to ease the yard off the lee rigging, recourse must be had to cluing up to leeward first. In this case, it will be best, if hands can be spared, to man both the clue-lines, bunt-lines, and weather-brace, at the same time ; thus, when the lee sheet is eased off, the weather-brace may be hauled in with ease, and the yard laid to the wind ; and, when the lee clue-line is half up, ease off the weather-sheet, and run up the weather clue-line ; then haul tight the lee brace, bowse tight the rolling tackle, and furl the sail.

To take in a jib.

Man well the down-haul, let go the haliards, ease off the sheet, and haul down briskly; and, when the sail is close down, ease away the out-haul, and haul the sail into the bowsprit cap; then let it be stowed away in the fore-staysail netting.

To haul in a lower studding-sail.

To haul in a lower studding-sail, blowing fresh, lead one of the sheets clear aft, and man it well: then lower away briskly the outer haliards, to spill the sail; ease off the tack, run in upon the sheet, and lower away the inner haliards as required.

To haul down a topmast studding-sail.

Man well the deck sheet and down haul, ease off the haliards, and haul the yard close out to the tack block; then ease away the tack, and haul down both upon the deck sheet and down haul.

To brail up and haul down a main-topmast-staysail.

Man well the lee brail and down-haul, having a few hands to gather in the slack of the weather brail; then let go the haliards, ease off the sheet, and haul down and brail up as briskly as possible. When the sail is down, let go the tack, and stop the sail over to the lee fore-rigging.

To brail up a mizen.

Man well the lee brails, ease off the mizen sheet, and brail up briskly, taking in at the same time the slack of the weather brails. After the sail is hauled up, stop its foot by passing the gasket round to leeward which will spill it.

To take in top-gallant-sail.

The lee sheet must be started first and clued up, and then the weather sheet.

To unbend a course.

First furl the sail, then cast off the rope-bands and make them fast round the sail, clear off the gaskets. When the rope-bands are all off, ease off the lee ear-ring, and lower down the sail; and, when the people upon deck have got hold of the lee part of the sail, ease away the weather ear-ring.

To unbend a top-sail.

First cast off the points of the reefs, keeping fast the ear-rings; then furl the sail and cast off the rope-bands, which make fast round the sail, clear off the gaskets. After this cast off the lee ear-rings and haul the lee side of the sail into the top; then haul in the weather side. Now unbend the reef-tackle, pendants, bunt-lines, and bow-lines; bight the sail snugly up together; and send it down by the clue-lines to windward or to leeward, as most convenient.

On scudding or bearing away in a storm.

When the waves run high, and sudden necessity requires to bear away, it should be considered that the lower sails forward, which the ship may be veered under when she comes before the wind, may be becalmed by the height of the waves breaking violently against the stern; and that therefore a close-reefed maintop-sail should be set to catch the wind, because it is a loftier sail, and may always be kept drawing full above the waves. This increases the ship's headway so much that the waves will not strike her abaft with so great a velocity as when her headway is less.

Hence it follows, that when going to scud before high waves, the close-reefed-maintopsail should be the last square sail taken in in a laboursome ship.

Of a ship overset on her side.

A common, but not always a certain method to recover ships from this dangerous situation, is to cut away the masts: however, as this expensive method may fail, stop-waters only, on the lee quarter at sea, may cause the ship to veer; or, where there is ground, an anchor or anchors dropped from the lee bow, may bring the wind a-head and take the sails a-back, so as to cast the ship on the other tack, and bring her upright.

To rig a main-topmast.

Tar the mast-head, get the cross-trees over, fix the bolsters and parcel them, put over Burton pendants, then the shrouds, breast-back-stay, proper and spring-stay and cap, sway up the mast and fid it, seize in the dead eyes, stay the mast, set up the shrouds, rattle them down, lash the bullock blocks to the mast head.

To rig a topgallant mast.

Send down the top-rope, reeve it through the sheeve-hole, and make it fast round the hounds of the mast and standing part of the rope, leaving enough end to make fast to the cap, which done, sway-away, when the head is through the cap, make fast the spare end, or standing part of the top-rope to the cap, cut the seizing, clap on the grommet, then the shrouds, back stays and stay, sway up the mast, fid it, and set the rigging up.

To rig a bowsprit.

Lash the collar fore-stay for the bob-stays and bowsprit shrouds, then the collar for the spring stays, then the block for the topmast stay, fix the man-rope, gammon the bowsprit, and set bob-stays and shrouds up.

To rig a jib-boom.

Put over the traveller, horses, guys, the topgallant stay-block, and lash on the blocks, for the topgallant bowline and jib down-haul block to the traveller.

To rig a lower yard.

Get it athwart the gunwale, lash the jeers, quarter clue-garnets, bunt-lines, heech-lines and slab-line blocks; then put over the yard arms, the horses, brace pendants, the yard-tackle pendants, then the top-sail sheet and lift-blocks, reeve the jeers, braces, lifts and yard-tackle falls, truss parcels, sway the yard up, and haul all taut.

To rig a fore-topsail yard.

Reeve a top-rope through the bullock-block and send it down, and having put over the horses, make the top-rope fast to the middle of the yard, stopping it to the yard-arm, sway it up above the top, put over the brace pendants and lift blocks, reeve the lifts and braces, cut the yard-arm seizing and cross the yard, lash the tye, bunt-line and clue-line blocks, reeve the tye and haliards, sway it up above the cap, and parcel it, reeve the clue-lines, bunt-lines and reef-tackles.

To rig a topgallant-yard.

Seize the clue-line blocks on, put the horses over the yard-arms, sway it upon the cap and rig the yard-arms, by putting on the brace-pendants and lifts, then cross the yard and parcel it.

To steer a ship when her rudder is lost.

To take a large spar, or part of a topmast, and cut it flat in the form of a stern-post, bore holes at proper distances in that part which is to be the fore-part of the preventer or additional stern-post, then take the thickest plank on board, and make it as near as possible into the form of a rudder, bore holes at proper distances in the fore-part of it, and in the after part of the preventer stern post to correspond with each other: and reeve rope grammots through those holes in the rudder, and after-part of the stern-post for the rudder to play upon.

Through the preventer stern-post reeve guys, and at the fore-part of them fix tackles, and then put the machine overboard; when it is in a proper position, or in a line with the ship's stern-post, lash the upper part of the preventer post to the upper part of the ship's stern-post, then hook tackles at or near the main chains and bowse taut on the guys to confine it to the lower part of the preventer stern-post:—having holes bored through the preventer, and proper stern-post, run an iron bolt through both, taking care not to touch the rudder, which will prevent the false stern-post from rising up or falling down.

By the guys on the after part of the rudder, and tackles affixed to them, the ship may be steered, taking care to bowse taut the tackles on the preventer stern-post to keep it close to the proper stern-post.

CATALOGUE

OF THE

TABLES, WITH EXAMPLES OF THE USES OF THOSE THAT ARE NOT EXPLAINED IN OTHER PARTS OF THIS WORK.



TABLES I. and II. *Difference of Latitude and Departure.*—The first table contains the difference of latitude and departure corresponding to distances not exceeding 300, and for courses to every quarter point of the compass. Table II. is of the same nature and extent but for courses consisting of whole degrees. The manner of using these tables is particularly explained under the article of Inspection, in the different Problems of Plane, Middle Latitude, and Mercator's Sailing.

TABLE III. *Meridional Parts.*—An explanation of this table may be found in pages 77 and 78, and the uses of it are shown in all the Problems of Mercator's Sailing.

TABLE IV. *The Sun's Declination*

TABLE IV. A. This table contains the equation of time for every noon at Greenwich and is to be reduced to any other hour by means of Table VI. A. Thus, suppose the equation of time was required for May 2, 1824, sea account at 10 A. M. apparent time, corresponding to May 1d 22h by the N. A. Table IV. A. gives the equation May 1, at noon, sub. 3m. 5s. and daily increase 8". Find this at the top in Table VI. A. and 22h. at the side, the corresponding correction 7s. increases the equation 3m. 5s. to 3m. 12s. which is the equation at the proposed time. Thus 7s. could have been subtractive if the equation had been decreasing, as it is in March. The equation of time being thus found, sub. 3m. 12s. is to be subtracted from the apparent time 22h. as in the table to get the mean time 21h. 56m. 48s. If the mean time 21h. 56m. 48s. had been given to find the apparent it must be applied differently from the direction in the table, and in this example must therefore be added to 21h. 56m. 48s. to obtain the apparent time 22h.

TABLE V. *For reducing the Sun's Declination given for noon at Greenwich to any other time under any other meridian.*—The manner of using the two preceding tables is explained in pages 110 and 111.

TABLE VI. *The Sun's Right Ascension.*—The Sun's mean right ascension given in this table may be used when a Nautical Almanac cannot be procured, and no great accuracy is required. The Table is to be entered at the top with the month, and at the side with the day of the month.

TABLE VII. *Amplitudes.*—This table is explained in page 112.

TABLE VIII. *Right Ascensions and Declinations of the principal fixed Stars.*—This table contains the right ascensions and declinations of the principal fixed stars, adapted to the 1st of January, 1820, and the annual variations in right ascension and declination, by means of which the right ascensions and declinations of any of these stars may be obtained for any time before or after the year 1820, by the rule at the end of the table. To illustrate the method of doing this, we shall here give the following examples.

To find the right ascension of a star at any time.

EXAMPLE I.

Required the right ascension of Aldebaran, January 1, 1824.
R. A. by the Table in 1820
Variation in 4 years add

h. m. s. Jan. 1, 1820
4 25 36
14

R. A. in January, 1824

4 25 50

EXAMPLE II.

Required the right ascension of Aldebaran, January 1, 1800.
R. A. by the Table in 1820
Variation in 20 years, subtract

h. m. s.
4 25 36
1 9

R. A. on January 1, 1800

4 24 27

EXAMPLE III.

Required the right ascension of Spica, May 20, 1826.
R. A. by the Table in 1820
Variation in 6 years 4½ months, add

h. m. s. May 20, 1820
13 15 43
20

R. A. May 20, 1826

13 16 3

EXAMPLE IV.

Required the right ascension of Sirius, November 6, 1807.
R. A. by the Table in 1820
Variation in 13 years subtract

h. m. s.
6 37 15
34

R. A. in January, 1807

6 36 39

Variation for 10 months and 6 days, add

2

R. A. November 6, 1807

6 36 41

The sun's right ascension for any time may be found accurately by the Nautical Almanac, by taking proportional parts of the daily difference as will be explained in the precepts of Table XXXI. But in cases where no great accuracy is required, the right ascension may be obtained within 2 or 3 minutes by means of Table VI.

To find the declination of a star at any time.

EXAMPLE I.

Required the declination of Aldebaran, January 1, 1824.
Declination by the Table in 1820
Variation in 4 years 33' add nearly

160° R. N.
1

Declination in 1824

160° 1' N

EXAMPLE II.

Required the declination of Aldebaran, January 1, 1810.
Declination by the Table in 1820
Variation in 10 years 1° 29' subtract

160° 6' N
1

Declination January 1, 1810

160° 7' N

EXAMPLE III.

Required the declination of Spica, May 20, 1828?	
Declination by the Table in 1820	100° 18' S.
Variation in 6 years 4½ months	2
Declination May 20, 1828	100° 15' S.

EXAMPLE IV.

Required the declination of Sirius, November 6, 1797?	
Declination by the Table in 1820	160° 28' S.
Var. in 22 years 1 month 24 days, is sub.	2
Declination November 6, 1797	160° 27' S.

The right ascensions and declinations obtained by the preceding calculations, are the mean values, to which must be applied the corrections for the Nutation and Aberration Tables XLII. XLIII. in cases where great accuracy is required, as is now done in the Nautical Almanac for 24 of the brightest stars for every 10 days in the year, and those numbers in the Nautical Almanac are to be preferred.

To find when a star will be on the meridian.

RULE. Find the right ascension of the sun and star in the preceding tables VI. and VIII; subtract the sun's right ascension from the star's, having previously increased the latter by 24 hours when the sun's right ascension is the greatest; the remainder will be the time of the star's coming to the meridian. If the remainder be greater than 12 hours, the star will come to the meridian after midnight; but if less than 12 hours, before midnight.

EXAMPLE I.

At what time will Aldebaran be on the meridian, January 1?	
Aldebaran's right ascension	4 26
Add	24
Sun's right ascension	28 26
Aldebaran souths in the evening	18 45
	9 41

EXAMPLE II.

At what time will Pollux be on the meridian, March 31?	
Pollux's right ascension	7 34
Sun's right ascension	38
Comes to the meridian in the evening	6 56

EXAMPLE III.

At what time will the star Regulus be on the meridian, December 12?	
Regulus' right ascension	9 59
Add	24
Sun's right ascension	33 54
After midnight	17 17
Subtract	16 42
In the morning	12
	4 42

EXAMPLE IV.

Required the time when the star Fomalhaut comes on the meridian, June 1?	
Fomalhaut's right ascension	22 48
Sun's right ascension	4 35
After midnight	18 13
Subtract	12
In the morning	6 13

To find what star will come upon the meridian at any given time.

RULE. Add the time from noon* to the right ascension of the sun, the sum (rejecting 24 hours when it exceeds 24) will be the right ascension of the star required to be known; with which enter the table of the star's right ascension, and find what star's right ascension agrees with, or comes the nearest to it, and that will be the star required, if the declination of the star agrees with the table, which may be ascertained by observing the meridian altitude of the star, the latitude of the place being given.

EXAMPLE I.

What star will be on the meridian about 10 at night, January 28?	
Sun's right ascension January 26	20 30
Given time 10 Hours P. M.	10
Subtract	30 30
Nearly answers to Sirius	24
	6 30

EXAMPLE II.

What star will be upon the meridian 30 minutes past four in the morning, May 10?	
Sun's right ascension May 10	3 7
Given time 16 hours 30 minutes	16 30
Right ascension of mid. heaven	19 57
Answers nearly to Altair in the Eagle.	

EXAMPLE III.

What star will be on the meridian at 6h. 53m. P. M. April 1?	
Sun's right ascension April 1	42
Given time	6 53
Right ascension of the meridian	7 35
Answers nearly to Pollux.	

EXAMPLE IV.

What star will be on the meridian, September 1, at 5h. 37m. P. M.?	
Sun's right ascension Sept. 1	10 41
Given time	5 37
Right ascension of the meridian	16 18
Answers nearly to Antares.	

In all the preceding examples, the right ascension of the sun ought to have been calculated for the moment of the star's passing the meridian, as will be more fully explained in the precepts of Table XXXI.

* The time from noon must be reckoned from the preceding noon, so that 4h. A. M. must be called 16h.

TABLE IX. *Semi-diurnal and Semi-nocturnal arches.*—This table exhibits half the time that a celestial object continues above the horizon when the latitude and declination are of the same name, or below when they are of a contrary name; the former time being usually called the semi-diurnal arch, the latter the semi-nocturnal arch; whence the time of rising and setting may be computed, by the following rules.

To find the time of the sun's rising and setting, and the length of the day and night.

RULE. Find the sun's declination at the top of the page and the latitude in either side column under the former, and opposite the latter, will be the time of the sun's setting if the latitude and declination are of the same name, but the time of rising if of different names.—The time of rising, subtracted from 12 hours, will give the time of setting, or the time of setting, subtracted from 12 hours, will give the time of rising.—The time of rising, being doubled, will give the length of the night, and the time of setting, being doubled, will give the length of the day.

EXAMPLE I.

Let it be required to find the time of the sun's rising and setting, with the length of the day and night in latitude 51° north, the 19th of July, 1820?

The sun's declination on the given day was $20^{\circ} 51'$ north, or 21° nearly, under which, and against the latitude 51° , stand 7h. 53m the time of the sun's setting on the given day in lat 51° north, which doubled, gives 15h. 46m. the length of the day, and by subtracting 7h. 53m. from 12h. the remainder 4h. 7m. is the time of the sun's rising, which doubled gives 8h. 14m. the length of the night.

But, when the sun has 21° south declination in this latitude, the time of sun setting becomes 4h. 7m. the time of rising 7h. 53m. the length of the day 8h. 14m. and the length of the night 15h. 46m. as was the case nearly on the 26th November, 1820.

EXAMPLE II.

Let it be required to find the time of the sun's rising, setting and the length of the day and night, at Boston, the 12th of July, 1820?

Under 22° which is nearly the declination on that day, and against $42^{\circ} 23'$ or 42° N the latitude of Boston stands the time of the sun's }
 setting } 7 21
 Subtracted from 12h. leaves sun-rising 4 36
 Sun-setting doubled is the length of day 14 50
 Sun-rising doubled is the length of night 9 10

EXAMPLE III.

Required the time of the sun's rising and setting, and length of day in latitude $51^{\circ} 23'$ S. May 13th, 1820?

Under the declination $18^{\circ} 55'$ or 19° N. }
 and against the lat. 51° S. }
 Stands the sun's rising } 6 54
 Time of sun's setting } 5 6
 } 2
 The length of the day 10 12
 And 6h. 54m. doubled is length of night 13 48

When a great degree of accuracy is required, proportional parts may be taken for the minutes of latitude and declination.

To find the time of rising and setting of stars whose declination does not exceed $23^{\circ} 28'$.

Enter Table IX. and find the star's declination at the top, and the latitude at the side, under the former, and opposite to the latter, will be the semi-diurnal arch, when the latitude and declination are both north or both south, but if one be north and the other south, the difference between the Tabular number and 12 hours will be the semi-diurnal arch. Find the time of the star's coming to the meridian according to the precepts of Table VIII and subtract therefrom the semi-diurnal arch, the difference will be the time of rising, or by adding together the semi-diurnal arch, and the time of passing the meridian, the time of setting will be obtained.

EXAMPLE IV.

Required when the star Arcturus rises and sets December 1, in latitude 51° N?
 The time of the star's coming to the meridian, or waiting in the morning, is nearly 9 39
 The star's declination 30° nearly, and against latitude 51° stand

Time of star's rising in the morning 1 51
 Added, gives the time of the star's setting 17 25
 12
 Star sets 26 minutes after 5 in the evening 5 26

EXAMPLE V.

What time will the Dog-Star Sirius rise and set at Philadelphia, Feb. 1?
 Under the declination, which is nearly 16° S. and against the latitude, which is nearly 40° N, stand

Subtracted from 12h. leaves half the time the star is above the horizon 5 4
 The star comes to the meridian in the evening nearly at 9 39
 Sum, rejecting 12 hours, is the time of setting in the morning 2 43
 Difference is the time of rising in the evening 4 35

In like manner may the rising and setting of any planet be found when the declination does not exceed $23^{\circ} 28'$, and the time of the passage over the meridian is known.

Suppose it was required to find the time of Jupiter's rising and setting, March 9, 1820. civil account, in the latitude of 52° N?

In the Nautical Almanac for 1820, I find that Jupiter passes the meridian March 7d. 23h. 10m. or March 8d. 11h. 10m. A. M. civil account, his declination being $10^{\circ} 55' S.$ or nearly 11° . Under the declination 11° , and opposite to the latitude 52° stand 6h. 58m. which is half the time Jupiter is below the horizon; this subtracted from 12h. leaves half the time that he is above the horizon, 5h. 2m.; this subtracted from 11h. 10m. A. M. leaves 6h. 8m. A. M. March 8, for the time of Jupiter's rising; and added to 11h. 10m. gives 4h. 12m. P. M. March 8, for the time of Jupiter's setting.

Suppose it was required to find the time of the moon's rising and setting, May 5, 1820, civil account, in the latitude of $52^{\circ} N$?

In the Nautical Almanac, page VI. I find that the moon passes the meridian May 4d. 18h. 7m. or May 5d. 6h. 7m. A. M. civil account; her declination being about $21^{\circ} S.$ Under the declination 21° , and opposite to the latitude 52° , stand 7h. 58', half the time the moon is below the horizon, which subtracted from 12h. leaves half the time she is above the horizon, 4h. 2m.; this subtracted from 6h. 7m. leaves 2h. 5m. A. M. the time of the moon's rising, and added to 6h. 7m. gives 10h. 9m. A. M. the time of her setting, nearly.

If greater accuracy is required, you must find the time at Greenwich corresponding to this approximate time of her rising and setting; then find the moon's declination, and the right ascensions of the sun and moon for that moment of time. The former subtracted from the latter leaves the corrected time of the moon's passing the meridian. With these data repeat the operation. In this way we may obtain the time of rising and setting to any degree of accuracy. Instead of taking the difference of the right ascension of the sun and moon, you may take the daily difference in the time of her coming to the meridian of Greenwich, and take a proportional part for the longitude of the place of observation (by means of table XXVIII.) and another proportional part, for the interval between the hour of passing the meridian, and the time of rising or setting.*

It may be noted, that the numbers of Table IX. were calculated for the moment the sun's centre appears in the true horizon; allowance ought to be made for the dip, parallax, and refraction, by which the sun and stars, when near the horizon, appear in general to be elevated above half a degree above their true place, and the moon as much below her true place.

TABLE X. *For finding the distance of any terrestrial object at sea.*—The explanation and use of this table is given in Problems VII. and VIII. pages 190, 191.

TABLE XI. *Table of Proportional Parts.*—The method of using this table is given in page 166.

TABLE XII. *Table of Refraction.*—Explained in page 108.

TABLE XIII. *Dip of the Horizon.*—Explained in page 109.

TABLE XIV. *Sun's Parallax in altitude.*—Explained in page 107.

TABLE XV. *Augmentation of the moon's semi-diameter.*—The moon's semi-diameter given in the Nautical Almanac is the same as would be seen by a spectator supposed to be placed at the centre of the earth, or nearly the same as would be seen by a spectator on the surface of the earth, when the moon is in the horizon. Now when the moon is in the zenith of the spectator placed at the surface, her distance from him is less than when at the horizon by a semi-diameter of the earth; consequently her apparent semi-diameter must be augmented in proportion as the distance is decreased, that is about one sixtieth part, or $16''$. At intermediate altitudes, between the horizon and zenith, the augmentation is proportional to the sine of the altitude, and the value for every 5° or 10° of altitude is given in Table XV. The augmentation corresponding to the altitude being found in the table, must be added to the semi-diameter taken from the Nautical Almanac for the time of observation reduced to Greenwich time, as was explained in page 166.

TABLE XVI. *Dip of the sea at different distances from the observer.*—Explained in page 109.

TABLE XVII. *For finding the difference between the refraction of a star and $60'$; also a log. corresponding.*

TABLE XVIII. *For finding the difference between the correction of the sun's altitude for parallax and refraction and $60'$, also a logarithm corresponding thereto.*—The manner of taking the numbers from the two preceding tables is explained in page 167, and the uses to which these tables may be applied are explained in pages 167 and 174.

TABLE XIX. *For finding a correction and logarithm used in the first method of working a lunar observation.*—The correction found in this table being subtracted from $59' 42''$ will leave a remainder equal to the correction of the moon's altitude for parallax

* In strictness, this last correction, found by the table, ought to be decreased in the ratio of 24h. to 24h. increased by the daily difference of the time of the moon's passing the meridian.

and refraction. It will be unnecessary here to point out the method of taking out this correction, as it is fully explained in the first pages of the table. It may not, however, be amiss to observe, that after constructing the logarithms of this table, it was concluded to subtract therefrom the greatest correction of the Table C corresponding, in order to render those corrections additive. Thus the logarithm corresponding to the alt. 30° and hor. par. $54'$ was found at first to be 2372, and for the hor. par. $54' 10''$ the correction was 2358, so that if these numbers had been published, the correction for seconds of parallax would have been subtractive; but as this would have been inconvenient, it was thought expedient to subtract from each of the numbers thus calculated, the greatest corresponding correction of Table C, which in the preceding example is 12, by this means the above numbers were reduced to 2360 and 2346 respectively, and the corrections of Table C were rendered additive. In a similar manner the rest of the logarithms of the table were calculated. It is owing to this circumstance that the corrections in Table C for $0'$ of parallax are greater than for any other number. Similar methods were used in calculating the other numbers of this table, and in arranging the Tables A and B.

TABLE XX. *Third correction of the apparent distance*—The method of finding the correction from this table is explained in pages 168, 174, 176.

TABLE XXI. *To reduce longitude into time, and the contrary*.—In the first column of this table are contained degrees and minutes of longitude, in the second the corresponding hours and minutes, or minutes and seconds of time; the other columns are a continuation of the first and second respectively. The use of this table will evidently appear by a few examples.

EXAMPLE I.

Required the time corresponding to $50^{\circ} 31'$
 Opposite 50° in col. 1 is 3 20 0
 31 " 2 4
 Sought time 3 22 4

EXAMPLE II.

Required the degrees and minutes corresponding to 6h 32m 20s.
 Opposite 6h 32m. 0s in col. 4 is $94^{\circ} 0'$
 1 20 in col. 2 is 20
 8 33 20

TABLE XXII. *Proportional Logarithms*.—These logarithms are very useful in finding the apparent time at Greenwich corresponding to the true distance of the moon from the sun or star as is explained in page 168. They may be also used like common logarithms, in working any proportion where the terms are given in degrees, minutes, and seconds, or in hours, minutes, and seconds, as in the examples page 177. The table is extended only to 3 or 3h and if any of the terms of a given proportion exceed 3° or 3h, you may take all the terms one grade lower; that is, reckon degrees as minutes, minutes as seconds, &c. and work the proportion as before; observing to write down the answer one grade higher, that is, you must estimate minutes as degrees, seconds as minutes, &c. Instead of taking all the terms one grade lower you may change two of the terms only, viz. one of the middle terms and one of the extreme terms, thus the 1st. and 3d. or the 1st. and 2d. may be taken one grade less, and the fourth term will be given correctly, but if the fourth term be taken one grade less, you must, after working the proportion, write it one grade higher, as is evident. To illustrate this we shall give the following examples.

EXAMPLE I.

If in 13 10 of time the sun rises $2^{\circ} 40'$ how much will it rise in 3 10 at the same rate?
 As 13 10 Prop. Log. ar. co. 2.9256
 Is to $2^{\circ} 40'$ Prop. Log. .0512 grade less.
 So is 3 10 Prop. Log. 1.7317
 To 53 24 Prop. Log.

EXAMPLE II.

If the sun's declination changes $16^{\circ} 19'$ in 24 hours, how much will it change in 6h. 2m. 7
 Here the 1st and 3d terms must be taken one grade less.
 As 24 0 P. L. ar. co. 2.3949
 Is to $16^{\circ} 19'$ P. L. 1.0428
 So is 6 2 P. L. 1.5301
 To 3 24 P. L. 1.5179

EXAMPLE III.

If in 12h the moon's longitude varies $7^{\circ} 1'$ what will it vary in 4h. 30m.
 Here all the terms must be taken one grade less.
 As 12 0 P. L. ar. co. 2.8234
 Is to 7 1 P. L. 1.409
 So is 4 30 P. L. 1.6185
 To 2 33 7 P. L.

Which taken one grade higher is $2^{\circ} 33' 2''$ the answer required.

EXAMPLE IV.

If in 16' the sun rises $5^{\circ} 27'$ how much will it rise in 1 10
 Here the 2d and 4th terms must be taken one grade less.
 As 16 0' ar. co. P. L. 2.9428
 Is to 5 27 P. L. 1.7193
 So is 1 10 P. L. 1.7547
 To 0 41' P. L. 2.4210

Which taken one grade higher is $41'$, the answer required.

TABLES XXIII. *For finding the latitude by two altitudes of the sun*.—The manner of using this table is explained in page 139, et seq.

TABLE XXIV. Natural Sines.—This table contains the natural sine and co-sine for every minute of the quadrant to the radius 100000, and is to be entered at the top or bottom with the degrees, and at the side marked M. with the minutes, the corresponding numbers will be the natural sine and co-sine respectively, observing that if the degrees are found at the top, the name sine, co-sine, and M. must also be found at the top, and the contrary if the degrees are found at the bottom. Thus 43366 is the natural sine of $25^{\circ} 42'$ or the co-sine of $64^{\circ} 18'$.

TABLE XXV. Logarithmic sines, tangents, and secants to every point and quarter point of the compass.—This table is to be used instead of table XXVII. when the course is given in points. The course is to be found in the side column, and opposite thereto will be the log. sine, tangent, &c. The names being found at the top when the course is less than 4 points, otherwise at the bottom.

TABLE XXVI. Logarithms of Numbers.—The explanation and uses of this table are given in page 28, et seq.

TABLE XXVII. Logarithmic Sines, Tangents, and Secants.—This table is explained in page 33, et seq.

TABLE XXVIII. For reducing the time of the Moon's passage over the meridian of Greenwich, to the time of her passage over any other meridian.—The manner of doing this is explained in page 124.

TABLE XXIX. Correction of the Moon's altitude for parallax and refraction.—The mean correction of the Moon's altitude is given in this table for every degree of altitude from 10° to 90° . The manner of using this table is explained in page 126.

TABLE XXX. For reducing the Moon's declination given in the Nautical Almanac for noon and midnight at Greenwich, to any other time under any other meridian.—The manner of using this table is explained in page 125. In addition to which it may be observed that 12h. are marked both at the bottom of the left hand column and at the top of the right hand column; but this can cause no embarrassment, because when the time at Greenwich is 12h. the declination must be taken from the Nautical Almanac for midnight, without any correction.

TABLE XXXI. For reducing the Sun's right ascension in time, as given in the Nautical Almanac for noon at Greenwich, to any other time under any other meridian.—This table is useful in finding the Sun's right ascension at any time, by means of the right ascension given in the second page of the Nautical Almanac for noon at Greenwich. This table must be entered at the top with a daily variation of the sun's right ascension, and in the left hand column with the given time from noon, or in the right hand column with the longitude of the place; under the former, and opposite the latter, will stand a correction in minutes and seconds, to be applied to the sun's right ascension at noon at Greenwich. The correction found with the time from noon, is to be added in the afternoon, but subtracted in the forenoon; and the correction found with the longitude of the place, is to be added in west, but subtracted in east longitude.

Instead of finding the correction separately for the longitude of the place and the time from noon, you may find the whole correction at one entry, in the following manner: Turn the ship's longitude into time (by Tab. XXI.) and add it to the given time when in west longitude, but subtract the longitude when east; the sum or difference will be the time at Greenwich; find this time in the side column* and the daily variation at the top, corresponding to which will be the sought correction; which is to be added to the sun's right ascension for the preceding noon at Greenwich.

EXAMPLE I.

Required the sun's right ascension at noon, May 24, 1820, sea account, in the longitude of 45° W. from Greenwich?

May 24, sea account is May 23, by N. A. The sun's right ascension by N. A. at Greenw. 4h. 0m. 26s.
Corr. Tab. XXXI. for 45° long. and daily var. 4m. 2sec. add

Right Ascension required 4 0 55

EXAMPLE II.

Required the sun's right ascension at noon, June 24, 1820, sea account, in the longitude of 120° E. from Greenwich?

June 24, sea account is June 23, by N. A. on which day at noon the sun's right asc. was 6h. 8m. 14s.
Corr. Tab. XXXI. for 120° long. and daily variation, 4m. 9'.4 sub.

Right Ascen. required 6 6 30

EXAMPLE III.

Required the sun's right ascension, May 24, 1820, at 4h. P. M. sea account, in long. of 45° W?

R. A. at noon in long. 45° W. by Ex. I. 4h. 0m. 55s.
Corr. in Tab. XXXI. for 4h. P. M. add

R. A. May 24, 1820, at 4h. P. M. 4 1 35

EXAMPLE IV.

Required the sun's right ascension, June 24, 1820, at 9h. A. M. sea account, in long. of 120° E?

R. A. at noon in long. 120° E. by Ex. II. 6h. 6m. 30s.
Corr. in Tab. XXXI. for 12 hours 2 5
for 9 hours 1 34

R. A. June 24, 1820, at 9h. A. M. 6 10 17

* If the time at Greenwich be more than 12h. you must first take out the correction for 12h. and then for the rest of the time; the sum of these two will be the correction.

The third and fourth examples may be worked by a single entry of Table XXXI. as follows.

EXAMPLE III.

Given time by N. A. May	d. h. m.
Long. 45° in time add	23 4 0
	3 0
Time at Greenwich	23 7 0
	h. m. s.
Sun's R. A. May 23, at noon by N. A.	4 0 25
Corr. Tab. XXXI. for 7h.	1 11
Sun's R. A. at 4h. P. M.	4 1 36
Differing 1s. from the former method.	

EXAMPLE IV.

Given time by N. A. June	d. h. m.
Long. 120° in time	23 21 0
	8 0
Time at Greenwich	23 13 0
	h. m. s.
Sun's R. A. June 23, at noon	6 8 1
Corr. Tab. XXXI. for 12h.	2 5
for 1h.	10
Sun's R. A. 21h. 0m.	6 10 16

If you wish to find accurately the time that any star comes to the meridian, or the time of rising or setting, you must take the sun's right ascension for noon at Greenwich, from the Nautical Almanac; then the star's right ascension from Table VIII. and with these, find the approximate time of rising, setting, or coming to the meridian, by the method already given in the precepts for using Tables VIII. and IX. Then calculate the sun's right ascension for this approximate time, and repeat the operation till the assumed and calculated times agree, and you will have the true time required.

To explain this method, I shall give the following examples.

*To find the time when a star comes to the meridian.***EXAMPLE I.**

At what time was Aldebaran on the meridian of a place in the longitude of $70^{\circ} 50'$ W. Jan. 2, 1820, sea account?

Jan. 2, sea account, is Jan. 1, N. A. on which day the sun's R. A. at noon at Greenwich was	h. m. s.
Aldebaran's R. A.	4h. 25m. 36s.
Add	24
	28 25 36
Difference is the approximate time	9 41 48
Now calculating the sun's R. A. for this time in the long. of $70^{\circ} 50'$ W. from Greenwich, I find it was	h. m. s.
Aldebaran's R. A. + 24h.	18 48 27
	28 25 36
True time of coming to the meridian	9 39 9

EXAMPLE II.

At what time was Pollux on the meridian of a place in the longitude of $70^{\circ} 46'$ W. March 31, 1820, sea account?

March 31, sea account, is March 30, N. A. on which day, at noon, the sun's right ascension was	h. m. s.
This, subtracted from R. A. of Pollux	0 25 41
	7 34 17
Approximate time of southing	6 58 39
Correction of the sun's R. A. from Table XXXI. for this time is	1 4
And for the long. $70^{\circ} 46'$ W. of Greenw.	43
The sum of these two corrections is	1 47
which subtracted from the approximate time of southing 6h. 58m. 36s. leaves the true time 6h. 56m. 48s.	

The method (used in the last example) of applying the corrections to the approximate time, instead of applying them to the right ascension of the sun, will be found the most expeditious; but it must be noted, that the corrections to be applied to the approximate time must have a contrary sign to what they would have when applied to the right ascension.

To find the time of rising or setting of a star.

RULE. Enter Table IX. with the declination of the star at the top, and the latitude of the place at the side; the corresponding number will be the time of the star's continuance above the horizon, when the latitude and declination are of the same name; but if they are of different names, the tabular number subtracted from 12h. will be the time of continuance above the horizon. Add this time to the star's right ascension, if you wish to find the time of setting; but subtract the former from the latter if you wish the time of rising. From this sum or difference subtract the sun's right ascension* corrected for the longitude of the place; the remainder will be the approximate time sought.† Enter Table XXXI. with the distance of this approximate time from noon, and the daily variation of the sun's right ascension: the correction corresponding is to be added to the approximate time in the forenoon, but subtracted in the afternoon, and you will have the corrected time of rising and setting.

* Increasing the number from which the subtraction is to be made, by 24 hours, when necessary.

† Rejecting 24 hours when it exceeds 24 hours. If the time of rising or setting be more than 12h. it will be after midnight; but if less than 12h. it will be before midnight.

EXAMPLE I.

At what time did the star Aldebaran set, May 24, 1820, sea account, in the latitude of $38^{\circ} 33'$ N. and the longitude of 77° W?

The star's declination was $16^{\circ} 8'$ N. and the latitude $38^{\circ} 53'$ N. corresponding to which in Table IX. is

Star's right ascension 6h. 54m. 4 28

Sum 11 20
May 24, sea acc. or May 23 by N. A.
at noon sun's R. A. 4h. 0m.
Corr. for long. 77° W. 1

Sum subtract 4 1

Remains approximate time of setting 7 19
Corr. in Tab. XXXI. for 7h. 19m. sub. 1

Corrected time of setting, P. M. 7 18

EXAMPLE II.

At what time did the Dog-Star Sirius rise in the latitude $39^{\circ} 20'$ N. and the longitude of $76^{\circ} 50'$ W. Jan. 2, 1820, sea account?

The star's declination is $16^{\circ} 28'$ S. and the latitude is $39^{\circ} 20'$ N. corresponding to which in Table IX. is nearly 6h. 56m.

Which subtracted from 12 0

Leaves the time of the star's being above the horizon 5 4

Subtract from star's R. A. 6 37

Remainder 1 33

Add 24

Sum 25 33

Jan. 2, sea acc. or Jan. 1, by N. A. at noon sun's R. A. 18h. 44m.

Corr. for long. $76^{\circ} 50'$ W. 1

Subtract the sum 18 45

Remains approxim. time of rising 6 48

Corr. in Tab. XXXI. for 6h. 48m. sub. 1

Corr. time of rising in the afternoon 6 47

TABLE XXXII. Variation of the sun's altitude in one minute from noon.

TABLE XXXIII. To reduce the numbers of Table XXXII. to other given intervals of time from noon.

The method of using the two preceding tables is explained in page 150 and 151.

TABLE XXXIV. Errors arising from a deviation of $1'$ in the surfaces of the central mirror.—This table shows the error arising in measuring an angle by an instrument of reflection from a deviation of $1'$ in the parallelism of the surfaces of the central mirror, the line of intersection of those surfaces (produced if necessary) being perpendicular to the plane of the instrument. If the line of intersection be inclined to that plane, the numbers in the table must, in general, be decreased in proportion to the sine of the angle of inclination.

The second, third, and fourth columns of the table are calculated upon the supposition that the surface of the horizon mirror is inclined 80° to the axis of the telescope, or that the angle intercepted between the ray incident on the horizon glass and the corresponding reflected ray passing through the telescope is 20° , which is the case in circular instruments of DE BORDA's construction, and on this supposition the errors of an instrument in measuring different angles may be ascertained by the rules in pages 98 and 106; when the intercepted angle is greater or less than 20° , which is the case in most sextants and quadrants, the error in any measured angle corresponding to an inclination of the surfaces of $1'$, may be obtained as follows.

Find in the first column the intercepted angle, and the sum of that angle and the observed distance; take the corresponding corrections from column 5th, and their difference will be the sought correction.

In a circular instrument you must find in the side column the sum and the difference of the intercepted angle and observed angle, and take out the corresponding corrections from column 5th, half their difference will be the sought correction. Having thus found the correction corresponding to $1'$, you may find the correction for other angles as in pages 98 and 106.

TABLE XXXV. Correction for a deviation of the telescope of an instrument of reflection from the parallelism to the plane of the instrument.—The uses of this table are explained in pages 97 and 105.

TABLE XXXVI. Correction of the mean refraction for various heights of the barometer and thermometer.—The use of this table is explained in page 108.

TABLE XXXVII. Latitudes and Longitudes of the fixed Stars.—This table contains the Latitudes and Longitudes of the principal fixed stars, adapted to the beginning of the year 1820, with the annual variations for precession and the secular equation, by which the mean values at any time may be obtained, in like manner as the Right Ascensions and declinations are from Table VIII.; by adding the correction of longitude after 1820, subtracting before 1820, and applying the correction of latitude with the same sign as in the table after 1820, but with a contrary sign before 1820.

EXAMPLE I. Required the Longitude and Latitude of α Pegasi, July 16, 1817

Long. by Table XXXVII.	11s 20° 58' 44"	Latitude by Table XXXVII.	19° 24' 44" N
Variation 1 year 64m. sub.	1 15	Variation 1 year 84m. sub.	0
Long. July 16, 1817	11 20 57 31		19 24 44 N

EXAMPLE II. Required the Longitude and Latitude of α Pegasi, July 1, 1822

Long. by Table XXXVII.	11s 20° 58' 44"	Latitude by Table XXXVII.	19° 24' 44" N.
Variation 24 years, add	2 5	Variation 24 years, add	0
Long. July 1, 1822	11 21 0 49	Latitude July 1, 1822	19 24 44 N

The latitudes and longitudes, thus obtained, are the mean values. When great accuracy is required, the corrections for the equation of the equinoxes Table XL and aberration, Table XII must be applied.

TABLE XXXVIII. Reduction of latitude and horizontal parallax.—This table contains the corrections to be subtracted from the latitude of the place of observation, and from the horizontal parallax of the Moon, given in the Nautical Almanac, in calculating eclipses of the Sun or occultations. Thus, if the latitude of the place was 40° and the Moon's horizontal parallax 57", the correction of latitude would be nearly 11 15", and that of parallax 4".7, so that the reduced latitude would be 39° 48' 42" and the reduced parallax 56' 55" 3. These values are to be used in occultations, but in eclipses of the Sun, this parallax is to be further decreased by 9" for the Sun's parallax. When the latitude is not given exactly in the table, the two nearest numbers must be found, and a proportional part of their difference is to be applied to one of the numbers as usual. In calculating this table, the ellipticity of the earth was supposed equal to $\frac{1}{298}$, as in the third edition of La Lande's Astronomy, and in Vince's Astronomy. This value differs but little from $\frac{1}{294}$ and $\frac{1}{295}$, deduced by La Place from two lunar equations in the third volume of his immortal work *La Mécanique Céleste*. In the second volume of the same work he calculated the ellipticity to be $\frac{1}{296}$ from the lengths of pendulums observed in different latitudes; this calculation corrected for a small mistake in the numerical coefficient of y in the tenth of his equations A" becomes $\frac{1}{297}$ which does not differ very much from the value assumed in this table.

TABLE XXXIX. Aberration of the Planets.—This table contains the aberration of the planets, to be applied to the true longitude or latitude, with the same sign as in the table. The argument at the side is the elongation of the planet from the Sun, that is, the difference of their geocentric longitudes, or its supplement to 360°. Thus, on July 19 1820, the longitude of the Sun was 3s 26° 38' the Geo long. of Venus 4s 13° 23', their difference 16° 45' is the elongation or distance from the inferior conjunction, corresponding to which is the aberration + 3" to be applied to the true longitude given by the tables to obtain the apparent longitude. The aberration of Mercury is given at its greatest, least and mean distances from the Sun. At the intermediate places, a proportional part of the differences of the nearest tabular numbers must be applied.

TABLES XL. & XLI. Equation of the Equinoxes and Aberration in Longitude.—Table XL contains the equation of the equinoxes in longitude common to all the heavenly bodies. The argument is the longitude of the Moon's ascending node given in page III. of the Nautical Almanac, the signs of longitude being found at the top or bottom, and the degrees at the side, the corresponding number with its sign is the equation of the equinoxes in longitude.

Table XLI contains the aberration of the stars in longitude and latitude to be calculated by the rules at the bottom of the tables. The signs of the argument being found at the top and the degrees at the side,* taking proportional parts for minutes. The corrections of longitude found in these tables, are to be applied, with their signs, to the mean longitude found in Table XXXVII and the correction of latitude, Table XLI is to be applied to the mean latitude deduced from Table XXXVII. Thus on July 16, 1820 by the examples at the bottom of Tables XL. XLI the equation of the equinoxes was + 1 2 and the aberration in longitude + 11" 5, these corrections being applied to the mean longitude of the star deduced from table XXXVII 11s 20° 59' 11" gives its apparent longitude 11s 20° 59' 21". In a similar manner the aberration in latitude - 5' 6 found at the bottom of Table XLI applied to the mean latitude 19° 24' 44" N. deduced from Table XXXVII. gives the apparent latitude of the star 19° 24' 39" N.

* The degrees in this and the following tables are to be found in the column marked D on the same horizontal line with the signs. Thus, if the signs are at the top of the table, the degrees must be found in the left column; otherwise in the right.

TABLES XLII. XLIII. *Aberration and Nutation in Right Ascension and Declination.* Table XLII. contains the aberration, and Table XLIII. the Nutation in Right Ascension and Declination, to be found by the rules at the bottom of the tables, and applied with their signs to the mean values deduced from Table VIII. Thus by Table VIII. the Right Ascension of α Pegasi, July 16, 1820, was 22h. 55' 49".6, and its declination $14^{\circ} 14' 10''$ N. The aberration of Right Ascension in time was nearly $+ 0''.8$, in declination $- 0''.7$. The Nutation in Right Ascension in time $- 0''.1$, in declination $- 2''.2$, as appears by the examples at the bottom of the tables. These corrections being applied to the mean values, give the apparent Right Ascension 22h. 55' 50".3, and the apparent declination $14^{\circ} 14' 7''$ N. The equation of the obliquity of the ecliptic may be calculated by the rule at the bottom of the table. Thus, on July 16, 1820, the equation was $+ 9''.5$, which applied to the mean obliquity $23^{\circ} 27' 48''.2$, gives the apparent obliquity $23^{\circ} 27' 57''.7$.

TABLE XLIV. *Augmentation of the Moon's Semi-diameter.*—This table is divided into four parts, and is useful in finding the augmentation of the moon's semi-diameter by means of the altitude and longitude of the nonagesimal when the moon's altitude is unknown. The precepts for this calculation are given at the bottom of the table, and for further illustration another example is added, in which it is required to find the augmentation at the commencement of the occultation calculated in Problem VII. of the Appendix, when the D's S. D. by the Nautical Almanac was $16' 18''.9$, her true latitude $1^{\circ} 55' 11''$ S. parallax in lat. $10' 23''.6$, altitude of the nonagesimal $81^{\circ} 17' 32''$, and the moon's apparent distance from the nonagesimal $51^{\circ} 38' 26''$, as in Example III. Prob. V. Appendix. In this case the arguments of Part I. are $81^{\circ} 17' 32'' + 51^{\circ} 38' 26''$ or nearly 4s. $12^{\circ} 56'$ and 0s. $29^{\circ} 39'$, and the corresponding corrections $+ 6''.00$, $+ 4''.05$, whose sum is $10''.05$. This in Part II. gives $+ 0''.10$. In Part III. with the moon's true latitude $1^{\circ} 55' 11''$ S. and her par. in lat. $10' 23''.6$, the correction is $- 0''.10$. The sum of these three parts is $+ 10''.05$, which being found at the side of Part IV. and the moon's horizontal S. D. $16' 18''.9$ at the top, gives the corresponding correction $+ 0''.40$. This connected with the three former-parts $+ 10''.05$, gives the sought augmentation $10''.45$, or $10''.4$, as in the example Prob. VII. Appendix. It may be observed that the calculation by Problem IV. will sometimes produce the supplement of the altitude of the nonagesimal, but this requires no alteration in the rule, since the result is the same whether the altitude or its supplement is used.

TABLE XLV. *Equation of Second Differences.*—This table contains the equation of the second differences of the moon's motion, or the correction to be made on account of her unequal velocity between the times marked in the Nautical Almanac. The manner of applying this correction is taught in Problems I. II. III. of the Appendix.

TABLE XLVI. *Tables of Latitudes and Longitudes.*—This table (as observed in the preface) has been completely revised for this edition, and the latitudes and longitudes of a great number of places are added to those given in the former editions of this work.

TABLE XLVII. *Tide Table.*—The explanation and uses of this table are given in page 213, et seq.

TABLE I.

Difference of Latitude and Departure for $\frac{1}{2}$ Point.

N $\frac{1}{2}$ E.			N $\frac{1}{2}$ W.			S $\frac{1}{2}$ E.			S $\frac{1}{2}$ W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	60.9	03.0	121	120.9	05.9	181	180.8	08.9
2	02.0	00.1	62	61.8	03.0	122	121.9	06.0	182	181.8	08.9
3	03.0	00.1	63	62.7	03.1	123	122.9	06.0	183	182.8	09.0
4	04.0	00.2	64	63.6	03.1	124	123.9	06.1	184	183.8	09.0
5	05.0	00.2	65	64.5	03.2	125	124.8	06.1	185	184.8	09.1
6	06.0	00.3	66	65.4	03.2	126	125.8	06.2	186	185.8	09.1
7	07.0	00.3	67	66.3	03.3	127	126.8	06.2	187	186.8	09.2
8	08.0	00.4	68	67.2	03.3	128	127.8	06.3	188	187.8	09.2
9	09.0	00.4	69	68.1	03.4	129	128.8	06.3	189	188.8	09.3
10	10.0	00.5	70	69.0	03.4	130	129.8	06.4	190	189.8	09.3
11	11.0	00.5	71	70.0	03.5	131	130.8	06.4	191	190.8	09.4
12	12.0	00.6	72	71.0	03.5	132	131.8	06.5	192	191.8	09.4
13	13.0	00.6	73	72.0	03.6	133	132.8	06.5	193	192.8	09.5
14	14.0	00.7	74	73.0	03.6	134	133.8	06.6	194	193.8	09.5
15	15.0	00.7	75	74.0	03.7	135	134.8	06.6	195	194.8	09.6
16	16.0	00.8	76	75.0	03.7	136	135.8	06.7	196	195.8	09.6
17	17.0	00.8	77	76.0	03.8	137	136.8	06.7	197	196.8	09.7
18	18.0	00.9	78	77.0	03.8	138	137.8	06.8	198	197.8	09.7
19	19.0	00.9	79	78.0	03.9	139	138.8	06.8	199	198.8	09.8
20	20.0	01.0	80	79.0	03.9	140	139.8	06.9	200	199.8	09.8
21	21.0	01.0	81	80.0	04.0	141	140.8	06.9	201	200.8	09.9
22	22.0	01.1	82	81.0	04.0	142	141.8	07.0	202	201.8	09.9
23	23.0	01.1	83	82.0	04.1	143	142.8	07.0	203	202.8	10.0
24	24.0	01.2	84	83.0	04.1	144	143.8	07.1	204	203.8	10.0
25	25.0	01.2	85	84.0	04.2	145	144.8	07.1	205	204.8	10.1
26	26.0	01.3	86	85.0	04.2	146	145.8	07.2	206	205.8	10.1
27	27.0	01.3	87	86.0	04.3	147	146.8	07.2	207	206.8	10.2
28	28.0	01.4	88	87.0	04.3	148	147.8	07.3	208	207.8	10.2
29	29.0	01.4	89	88.0	04.4	149	148.8	07.3	209	208.8	10.3
30	30.0	01.5	90	89.0	04.4	150	149.8	07.4	210	209.8	10.3
31	31.0	01.5	91	90.0	04.5	151	150.8	07.4	211	210.8	10.4
32	32.0	01.6	92	91.0	04.5	152	151.8	07.5	212	211.8	10.4
33	33.0	01.6	93	92.0	04.6	153	152.8	07.5	213	212.8	10.5
34	34.0	01.7	94	93.0	04.6	154	153.8	07.6	214	213.8	10.5
35	35.0	01.7	95	94.0	04.7	155	154.8	07.6	215	214.8	10.5
36	36.0	01.8	96	95.0	04.7	156	155.8	07.7	216	215.8	10.6
37	37.0	01.8	97	96.0	04.8	157	156.8	07.7	217	216.8	10.6
38	38.0	01.9	98	97.0	04.8	158	157.8	07.8	218	217.8	10.7
39	39.0	01.9	99	98.0	04.9	159	158.8	07.8	219	218.8	10.7
40	40.0	02.0	100	99.0	04.9	160	159.8	07.9	220	219.8	10.8
41	41.0	02.0	101	100.0	05.0	161	160.8	07.9	221	220.8	10.8
42	42.0	02.1	102	101.0	05.0	162	161.8	08.0	222	221.8	10.9
43	43.0	02.1	103	102.0	05.1	163	162.8	08.0	223	222.8	10.9
44	44.0	02.2	104	103.0	05.1	164	163.8	08.0	224	223.8	11.0
45	45.0	02.2	105	104.0	05.2	165	164.8	08.1	225	224.8	11.0
46	46.0	02.3	106	105.0	05.2	166	165.8	08.1	226	225.8	11.1
47	47.0	02.3	107	106.0	05.3	167	166.8	08.2	227	226.8	11.1
48	48.0	02.4	108	107.0	05.3	168	167.8	08.2	228	227.8	11.2
49	49.0	02.4	109	108.0	05.3	169	168.8	08.3	229	228.8	11.2
50	50.0	02.5	110	109.0	05.4	170	169.8	08.3	230	229.8	11.3
51	51.0	02.5	111	110.0	05.4	171	170.8	08.4	231	230.8	11.3
52	52.0	02.6	112	111.0	05.5	172	171.8	08.4	232	231.8	11.4
53	53.0	02.6	113	112.0	05.5	173	172.8	08.5	233	232.8	11.4
54	54.0	02.6	114	113.0	05.6	174	173.8	08.5	234	233.8	11.5
55	55.0	02.7	115	114.0	05.6	175	174.8	08.6	235	234.8	11.5
56	56.0	02.7	116	115.0	05.7	176	175.8	08.6	236	235.8	11.6
57	57.0	02.8	117	116.0	05.7	177	176.8	08.7	237	236.8	11.6
58	58.0	02.8	118	117.0	05.8	178	177.8	08.7	238	237.8	11.7
59	59.0	02.9	119	118.0	05.8	179	178.8	08.8	239	238.8	11.7
60	60.0	02.9	120	119.0	05.9	180	179.8	08.8	240	239.8	11.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E. 45.			E. 45.			W. 45.			W. 45.		
									(For 7 $\frac{1}{2}$ Points.)		

TABLE I.

Difference of Latitude and Departure for $\frac{1}{2}$ Point.

N. $\frac{1}{2}$ E.			N. $\frac{1}{2}$ W.			S. $\frac{1}{2}$ E.			S. $\frac{1}{2}$ W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.0	121	120.4	11.9	181	180.1	17.7
2	02.0	00.2	62	61.7	06.1	22	121.4	12.0	82	181.1	17.8
3	03.0	00.3	63	62.7	06.2	23	122.4	12.1	83	182.1	17.9
4	04.0	00.4	64	63.7	06.3	24	123.4	12.2	84	183.1	18.0
5	05.0	00.5	65	64.7	06.4	25	124.4	12.3	85	184.1	18.1
6	06.0	00.6	66	65.7	06.5	26	125.4	12.4	86	185.1	18.2
7	07.0	00.7	67	66.7	06.6	27	126.4	12.4	87	186.1	18.3
8	08.0	00.8	68	67.7	06.7	28	127.4	12.5	88	187.1	18.4
9	09.0	00.9	69	68.7	06.8	29	128.4	12.6	89	188.1	18.5
10	10.0	01.0	70	69.7	06.9	30	129.4	12.7	90	189.1	18.6
11	10.9	01.1	71	70.7	07.0	131	130.4	12.8	191	190.1	18.7
12	11.9	01.2	72	71.7	07.1	32	131.4	12.9	92	191.1	18.8
13	12.9	01.3	73	72.6	07.2	33	132.4	13.0	93	192.1	18.9
14	13.9	01.4	74	73.6	07.3	34	133.4	13.1	94	193.1	19.0
15	14.9	01.5	75	74.6	07.4	35	134.4	13.2	95	194.1	19.1
16	15.9	01.6	76	75.6	07.4	36	135.4	13.3	96	195.1	19.2
17	16.9	01.7	77	76.6	07.5	37	136.4	13.4	97	196.1	19.3
18	17.9	01.8	78	77.6	07.6	38	137.4	13.5	98	197.0	19.4
19	18.9	01.9	79	78.6	07.7	39	138.4	13.6	99	198.0	19.5
20	19.9	02.0	80	79.6	07.8	40	139.4	13.7	200	199.0	19.6
21	20.9	02.1	81	80.6	07.9	141	140.4	13.8	201	200.0	19.7
22	21.9	02.2	82	81.6	08.0	42	141.4	13.9	202	201.0	19.8
23	22.9	02.3	83	82.6	08.1	43	142.4	14.0	03	202.0	19.9
24	23.9	02.4	84	83.6	08.2	44	143.4	14.1	04	203.0	20.0
25	24.9	02.5	85	84.6	08.3	45	144.4	14.2	05	204.0	20.1
26	25.9	02.5	86	85.6	08.4	46	145.4	14.3	06	205.0	20.2
27	26.9	02.6	87	86.6	08.5	47	146.4	14.4	07	206.0	20.3
28	27.9	02.7	88	87.6	08.6	48	147.4	14.5	08	207.0	20.4
29	28.9	02.8	89	88.6	08.7	49	148.4	14.6	09	208.0	20.5
30	29.9	02.9	90	89.6	08.8	50	149.4	14.7	10	209.0	20.6
31	30.9	03.0	91	90.6	08.9	151	150.4	14.8	211	210.0	20.7
32	31.8	03.1	92	91.6	09.0	52	151.4	14.9	12	211.0	20.8
33	32.8	03.2	93	92.6	09.1	53	152.4	15.0	13	212.0	20.9
34	33.8	03.3	94	93.6	09.2	54	153.4	15.1	14	213.0	21.0
35	34.8	03.4	95	94.6	09.3	55	154.4	15.2	15	214.0	21.1
36	35.8	03.5	96	95.6	09.4	56	155.4	15.3	16	215.0	21.2
37	36.8	03.6	97	96.6	09.5	57	156.4	15.4	17	216.0	21.3
38	37.8	03.7	98	97.6	09.6	58	157.4	15.5	18	217.0	21.4
39	38.8	03.8	99	98.6	09.7	59	158.4	15.6	19	217.9	21.5
40	39.8	03.9	100	99.6	09.8	60	159.4	15.7	20	218.9	21.6
41	40.8	04.0	101	100.6	09.9	161	160.4	15.8	221	219.9	21.7
42	41.8	04.1	02	101.6	10.0	62	161.4	15.9	222	220.9	21.8
43	42.8	04.2	03	102.6	10.1	63	162.4	16.0	23	221.9	21.9
44	43.8	04.3	04	103.6	10.2	64	163.4	16.1	24	222.9	22.0
45	44.8	04.4	05	104.6	10.3	65	164.4	16.2	25	223.9	22.1
46	45.8	04.5	06	105.6	10.4	66	165.4	16.3	26	224.9	22.2
47	46.8	04.6	07	106.6	10.5	67	166.4	16.4	27	225.9	22.3
48	47.8	04.7	08	107.6	10.6	68	167.4	16.5	28	226.9	22.4
49	48.8	04.8	09	108.6	10.7	69	168.4	16.6	29	227.9	22.5
50	49.8	04.9	10	109.6	10.8	70	169.4	16.7	30	228.9	22.6
51	50.8	05.0	111	110.6	10.9	171	170.4	16.8	231	229.9	22.7
52	51.7	05.1	12	111.6	11.0	72	171.4	16.9	32	230.9	22.8
53	52.7	05.2	13	112.6	11.1	73	172.4	17.0	33	231.9	22.9
54	53.7	05.3	14	113.6	11.2	74	173.4	17.1	34	232.9	23.0
55	54.7	05.4	15	114.6	11.3	75	174.4	17.2	35	233.9	23.1
56	55.7	05.5	16	115.6	11.4	76	175.4	17.3	36	234.9	23.2
57	56.7	05.6	17	116.6	11.5	77	176.4	17.4	37	235.9	23.3
58	57.7	05.7	18	117.6	11.6	78	177.4	17.5	38	236.9	23.4
59	58.7	05.8	19	118.6	11.7	79	178.4	17.6	39	237.9	23.5
60	59.7	05.9	20	119.6	11.8	80	179.4	17.7	40	238.9	23.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E. $\frac{1}{2}$ N.			E. $\frac{1}{2}$ S.			W. $\frac{1}{2}$ N.			W. $\frac{1}{2}$ S.		
									[For 7 $\frac{1}{2}$ Points.]		

3

Difference of Latitude and Departure for 1 Point.

N.4.E.			N.4.W.			S.4.E.			S.4.W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 1	61	60 3	09 0	121	119 7	17 8	181	119 0	26 6	241	138 4	35 4
2	02 0	00 3	62	61 3	09 1	122	120 7	17 9	182	120 0	26 7	242	139 4	35 5
3	03 0	00 4	63	62 3	09 2	123	121 7	18 0	183	121 0	26 9	243	140 4	35 7
4	04 0	00 6	64	63 3	09 4	124	122 7	18 2	184	122 0	27 0	244	141 4	35 8
5	04 9	00 7	65	64 3	09 5	125	123 6	18 3	185	123 0	27 1	245	142 3	35 9
6	05 9	00 9	66	65 3	09 7	126	124 6	18 5	186	124 0	27 3	246	143 3	36 1
7	06 9	01 0	67	66 3	09 8	127	125 6	18 6	187	125 0	27 4	247	144 3	36 2
8	07 9	01 2	68	67 3	10 0	128	126 6	18 8	188	126 0	27 6	248	145 3	36 4
9	08 9	01 3	69	68 3	10 1	129	127 6	18 9	189	127 0	27 7	249	146 3	36 5
10	09 9	01 5	70	69 2	10 3	130	128 6	19 1	190	127 5	27 9	250	147 3	36 7
11	10 9	01 6	71	70 2	10 4	131	129 6	19 2	191	128 5	28 0	251	148 3	36 8
12	11 9	01 6	72	71 2	10 6	132	130 6	19 4	192	129 5	28 2	252	149 3	37 0
13	12 9	01 9	73	72 2	10 7	133	131 6	19 5	193	130 5	28 3	253	150 3	37 1
14	13 9	02 1	74	73 2	10 9	134	132 5	19 7	194	131 5	28 5	254	151 3	37 3
15	14 8	02 2	75	74 2	11 0	135	133 5	19 8	195	132 5	28 6	255	152 2	37 4
16	15 8	02 3	76	75 2	11 2	136	134 5	20 0	196	133 5	28 8	256	153 2	37 6
17	16 8	02 5	77	76 2	11 3	137	135 5	20 1	197	134 5	28 9	257	154 2	37 7
18	17 8	02 6	78	77 2	11 4	138	136 5	20 2	198	135 5	29 1	258	155 2	37 9
19	18 8	02 8	79	78 1	11 6	139	137 5	20 4	199	136 5	29 2	259	156 2	38 0
20	19 8	02 9	80	79 1	11 7	140	138 5	20 5	200	137 5	29 3	260	157 2	38 1
21	20 8	03 1	81	80 1	11 9	141	139 5	20 7	201	138 5	29 5	261	158 2	38 3
22	21 8	03 2	82	81 1	12 0	142	140 5	20 8	202	139 5	29 6	262	159 2	38 4
23	21 8	03 4	83	82 1	12 2	143	141 5	21 0	203	140 8	29 8	263	160 2	38 6
24	23 7	03 5	84	83 1	12 3	144	142 4	21 1	204	141 8	29 9	264	161 1	38 7
25	24 7	03 7	85	84 1	12 5	145	143 4	21 3	205	142 8	30 1	265	162 1	38 9
26	25 7	03 8	86	85 1	12 6	146	144 4	21 4	206	143 8	30 2	266	163 1	39 0
27	26 7	04 0	87	86 1	12 8	147	145 4	21 6	207	144 8	30 4	267	164 1	39 2
28	27 7	04 1	88	87 0	12 9	148	146 4	21 7	208	145 7	30 5	268	165 1	39 3
29	28 7	04 3	89	88 0	13 1	149	147 4	21 9	209	146 7	30 7	269	166 1	39 5
30	29 7	04 4	90	89 0	13 2	150	148 4	22 0	210	147 7	30 8	270	167 1	39 6
31	30 7	04 5	91	90 0	13 4	151	149 4	22 2	211	148 7	31 0	271	168 1	39 8
32	31 7	04 7	92	91 0	13 5	152	150 4	22 3	212	149 7	31 1	272	169 1	39 9
33	32 6	04 8	93	92 0	13 6	153	151 3	22 4	213	150 7	31 3	273	170 0	40 1
34	33 6	05 0	94	93 0	13 8	154	152 3	22 6	214	151 7	31 4	274	171 0	40 2
35	34 6	05 1	95	94 0	13 9	155	153 3	22 7	215	152 7	31 5	275	172 0	40 4
36	35 6	05 3	96	95 0	14 1	156	154 3	22 9	216	153 7	31 7	276	173 0	40 5
37	36 6	05 4	97	96 0	14 2	157	155 3	23 0	217	154 7	31 8	277	174 0	40 6
38	37 6	05 6	98	96 9	14 4	158	156 3	23 2	218	155 6	32 0	278	175 0	40 8
39	38 6	05 7	99	97 9	14 5	159	157 3	23 3	219	156 6	32 1	279	176 0	40 9
40	39 6	05 9	100	98 9	14 7	160	158 3	23 5	220	157 6	32 3	280	177 0	41 1
41	40 6	06 0	101	99 9	14 8	161	159 3	23 6	221	158 6	32 4	281	178 0	41 2
42	41 5	06 2	102	100 9	15 0	162	160 2	23 8	222	159 6	32 6	282	179 9	41 4
43	42 5	06 3	103	101 9	15 1	163	161 2	23 9	223	160 6	32 7	283	180 9	41 5
44	43 5	06 5	104	102 9	15 3	164	162 2	24 1	224	161 6	32 9	284	181 9	41 7
45	44 5	06 6	105	103 9	15 4	165	163 2	24 2	225	162 6	33 0	285	182 9	41 9
46	45 5	06 7	106	104 9	15 6	166	164 2	24 4	226	163 6	33 2	286	183 9	42 0
47	46 5	06 9	107	105 8	15 7	167	165 2	24 5	227	164 5	33 3	287	184 9	42 1
48	47 5	07 0	108	106 8	15 8	168	166 2	24 7	228	165 5	33 5	288	185 9	42 3
49	48 5	07 2	109	107 8	16 0	169	167 2	24 8	229	166 5	33 6	289	186 9	42 4
50	49 5	07 3	110	108 8	16 1	170	168 2	24 9	230	167 5	33 7	290	187 9	42 6
51	50 4	07 5	111	109 9	16 3	171	169 1	25 1	231	168 5	33 9	291	187 9	42 7
52	51 4	07 6	112	110 8	16 4	172	170 1	25 2	232	169 5	34 0	292	188 8	42 8
53	52 4	07 8	113	111 8	16 6	173	171 1	25 4	233	170 5	34 2	293	189 8	43 0
54	53 4	07 9	114	112 8	16 7	174	172 1	25 5	234	171 5	34 3	294	190 8	43 1
55	54 4	08 1	115	113 8	16 9	175	173 1	25 7	235	172 5	34 5	295	191 8	43 3
56	55 4	08 2	116	114 7	17 0	176	174 1	25 8	236	173 4	34 6	296	192 8	43 4
57	56 4	08 4	117	115 7	17 2	177	175 1	26 0	237	174 4	34 8	297	193 8	43 6
58	57 4	08 5	118	116 7	17 3	178	176 1	26 1	238	175 4	34 9	298	194 8	43 7
59	58 4	08 7	119	117 7	17 5	179	177 1	26 3	239	176 4	35 1	299	195 8	43 9
60	59 4	08 8	120	118 7	17 6	180	178 1	26 4	240	177 4	35 2	300	196 8	44 0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.4.N.			E.4.S.			W.4.N.			W.4.S.			[For 74 Points.		

TABLE I.

Difference of Latitude and Departure for 1 Point.

N h E			N h W			S h E			S h W		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	59 8	11 9	121	118 7	23 6	181	177 5	35 3
2	02 0	00 4	62	60 5	12 1	22	119 7	25 8	82	178 5	35 5
3	02 9	00 6	63	61 8	12 3	23	120 6	24 0	83	179 5	35 7
4	03 9	00 8	64	62 8	12 5	24	121 6	24 2	84	180 5	35 9
5	04 9	01 0	65	63 8	12 7	25	122 6	24 4	85	181 4	36 1
6	05 9	01 2	66	64 7	12 9	26	123 6	24 6	86	182 4	36 3
7	06 9	01 4	67	65 7	13 1	27	124 6	24 8	87	183 4	36 5
8	07 8	01 6	68	66 7	13 3	28	125 5	25 0	88	184 4	36 7
9	08 8	01 8	69	67 7	13 5	29	126 5	25 2	89	185 4	36 9
10	09 8	02 0	70	68 7	13 7	30	127 5	25 4	90	186 3	37 1
11	10 8	02 1	71	69 6	13 9	31	128 5	25 6	91	187 3	37 3
12	11 8	02 3	72	70 6	14 0	32	129 5	25 8	92	188 3	37 5
13	12 8	02 5	73	71 6	14 2	33	130 4	25 9	93	189 3	37 7
14	13 7	02 7	74	72 6	14 4	34	131 4	26 1	94	190 3	37 8
15	14 7	02 9	75	73 6	14 6	35	132 4	26 3	95	191 3	38 0
16	15 7	03 1	76	74 5	14 8	36	133 4	26 5	96	192 2	38 2
17	16 7	03 3	77	75 5	15 0	37	134 4	26 7	97	193 2	38 4
18	17 7	03 5	78	76 5	15 2	38	135 3	26 9	98	194 2	38 6
19	18 6	03 7	79	77 5	15 4	39	136 3	27 1	99	195 2	38 8
20	19 6	03 9	80	78 5	15 6	40	137 3	27 3	200	196 2	39 0
21	20 6	04 1	81	79 4	15 8	41	138 3	27 5	211	197 1	39 2
22	21 6	04 3	82	80 4	16 0	42	139 3	27 7	22	198 1	39 4
23	22 6	04 5	83	81 4	16 2	43	140 3	27 9	23	199 1	39 6
24	23 5	04 7	84	82 4	16 4	44	141 3	28 1	24	200 1	39 8
25	24 5	04 9	85	83 4	16 6	45	142 2	28 3	25	201 1	40 0
26	25 5	05 1	86	84 3	16 8	46	143 2	28 5	26	202 0	40 2
27	26 5	05 3	87	85 3	17 0	47	144 2	28 7	27	203 0	40 4
28	27 5	05 5	88	86 3	17 2	48	145 2	28 9	28	204 0	40 6
29	28 4	05 7	89	87 3	17 4	49	146 1	29 1	29	205 0	40 8
30	29 4	05 9	90	88 3	17 6	50	147 1	29 3	30	206 0	41 0
31	30 4	06 0	91	89 3	17 8	51	148 1	29 5	211	206 9	41 2
32	31 4	06 2	92	90 2	17 9	52	149 1	29 7	22	207 9	41 4
33	32 4	06 4	93	91 2	18 1	53	150 1	29 8	23	208 9	41 6
34	33 3	06 6	94	92 2	18 3	54	151 0	30 0	24	209 9	41 7
35	34 3	06 8	95	93 2	18 5	55	152 0	30 2	25	210 9	41 9
36	35 3	07 0	96	94 2	18 7	56	153 0	30 4	26	211 8	42 1
37	36 3	07 2	97	95 1	18 9	57	154 0	30 6	27	212 8	42 3
38	37 3	07 4	98	96 1	19 1	58	155 0	30 8	28	213 8	42 5
39	38 3	07 6	99	97 1	19 3	59	155 9	31 0	29	214 8	42 7
40	39 2	07 8	100	98 1	19 5	60	156 9	31 2	30	215 8	42 9
41	40 2	08 0	101	99 1	19 7	61	157 9	31 4	211	216 8	43 1
42	41 2	08 2	102	100 0	19 9	62	158 9	31 6	22	217 7	43 3
43	42 2	08 4	103	101 0	20 1	63	159 9	31 8	23	218 7	43 5
44	43 2	08 6	104	102 0	20 3	64	160 8	32 0	24	219 7	43 7
45	44 1	08 8	105	103 0	20 5	65	161 8	32 2	25	220 7	43 9
46	45 1	09 0	106	104 0	20 7	66	162 8	32 4	26	221 7	44 1
47	46 1	09 2	107	104 9	20 9	67	163 8	32 6	27	222 6	44 3
48	47 1	09 4	108	105 9	21 1	68	164 8	32 8	28	223 6	44 5
49	48 1	09 6	109	106 9	21 3	69	165 8	33 0	29	224 6	44 7
50	49 0	09 8	110	107 9	21 5	70	166 7	33 2	30	225 6	44 9
51	50 0	09 9	111	108 9	21 7	171	167 7	33 4	211	226 6	45 1
52	51 0	10 1	112	109 8	21 9	72	168 7	33 6	22	227 5	45 3
53	52 0	10 3	113	110 8	22 0	73	169 7	33 8	23	228 5	45 5
54	53 0	10 5	114	111 8	22 2	74	170 7	33 9	24	229 5	45 7
55	53 9	10 7	115	112 8	22 4	75	171 6	34 1	25	230 5	45 8
56	54 9	10 9	116	113 8	22 6	76	172 6	34 3	26	231 5	46 0
57	55 9	11 1	117	114 8	22 8	77	173 6	34 5	27	232 4	46 2
58	56 9	11 3	118	115 7	23 0	78	174 6	34 7	28	233 4	46 4
59	57 9	11 5	119	116 7	23 2	79	175 6	34 9	29	234 4	46 6
60	58 8	11 7	120	117 7	23 4	80	176 5	35 1	40	235 4	46 8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E. b. N.			E. b. S.			W. b. N.			W. b. S.		
									[For 1 Point.]		

TABLE I.

6

Difference of Latitude and Departure for 1½ Points.

N. by E. ½ E.			N. by W. ½ W.			S. by E. ½ E.			S. by W. ½ W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 0	61	59 2	14 8	121	117 4	29 1	181	175 5	44 0
2	01 9	00 5	62	60 1	15 1	22	118 3	29 6	82	176 5	44 2
3	02 9	01 0	63	61 1	15 3	23	119 3	29 9	83	177 5	44 5
4	03 9	01 0	64	62 1	15 6	24	120 3	30 1	84	178 5	44 7
5	04 9	01 2	65	63 1	15 8	25	121 3	30 4	85	179 5	45 0
6	05 8	01 5	66	64 0	16 0	26	122 2	30 6	86	180 4	45 2
7	06 8	01 7	67	65 0	16 3	27	123 2	30 9	87	181 4	45 4
8	07 8	01 9	68	66 0	16 5	28	124 2	31 1	88	182 4	45 7
9	08 7	02 2	69	66 9	16 8	29	125 1	31 3	89	183 3	45 9
10	09 7	02 4	70	67 9	17 0	30	126 1	31 6	90	184 3	46 2
11	10 7	02 7	71	68 8	17 3	31	127 1	31 8	191	185 3	46 4
12	11 6	02 9	72	69 8	17 5	32	128 0	32 1	92	186 2	46 7
13	12 6	03 2	73	70 8	17 7	33	129 0	32 3	93	187 2	46 9
14	13 6	03 4	74	71 8	18 0	34	130 0	32 6	94	188 2	47 1
15	14 6	03 6	75	72 8	18 2	35	131 0	32 8	95	189 2	47 4
16	15 6	03 9	76	73 7	18 5	36	131 9	33 0	96	190 1	47 6
17	16 6	04 1	77	74 7	18 7	37	132 9	33 3	97	191 1	47 9
18	17 6	04 4	78	75 7	19 0	38	133 9	33 5	98	192 1	48 1
19	18 4	04 6	79	76 6	19 2	39	134 8	33 8	99	193 0	48 4
20	19 4	04 9	80	77 6	19 4	40	135 8	34 0	200	194 0	48 6
21	20 4	05 1	81	78 6	19 7	41	136 8	34 3	201	195 0	48 8
22	21 3	05 3	82	79 5	19 9	42	137 7	34 5	02	195 9	49 1
23	22 3	05 6	83	80 5	20 2	43	138 7	34 7	03	196 9	49 3
24	23 3	05 8	84	81 5	20 4	44	139 7	35 0	04	197 9	49 6
25	24 3	06 1	85	82 5	20 7	45	140 7	35 2	05	198 9	49 8
26	25 2	06 3	86	83 5	20 9	46	141 6	35 5	06	199 8	50 1
27	26 2	06 6	87	84 4	21 1	47	142 6	35 7	07	200 8	50 3
28	27 2	06 8	88	85 4	21 4	48	143 6	36 0	08	201 8	50 5
29	28 1	07 0	89	86 4	21 6	49	144 5	36 2	09	202 7	50 8
30	29 1	07 3	90	87 4	21 9	50	145 5	36 4	10	203 7	51 0
31	30 1	07 5	91	88 3	22 1	51	146 5	36 7	211	204 7	51 1
32	31 0	07 8	92	89 2	22 4	52	147 4	36 9	12	205 6	51 3
33	32 0	08 0	93	90 2	22 6	53	148 4	37 2	13	206 6	51 8
34	33 0	08 3	94	91 2	22 8	54	149 4	37 4	14	207 6	52 0
35	34 0	08 5	95	92 2	23 1	55	150 4	37 7	15	208 6	52 2
36	34 9	08 7	96	93 1	23 3	56	151 3	37 9	16	209 5	52 5
37	35 9	09 0	97	94 1	23 6	57	152 3	38 1	17	210 5	52 7
38	36 9	09 2	98	95 1	23 8	58	153 3	38 4	18	211 5	53 0
39	37 8	09 5	99	96 0	24 1	59	154 2	38 6	19	212 4	53 2
40	38 8	09 7	100	97 0	24 3	60	155 2	38 9	20	213 4	53 5
41	39 8	10 0	101	98 0	24 5	61	156 2	39 1	21	214 4	53 7
42	40 7	10 2	02	98 9	24 8	62	157 1	39 4	22	215 3	53 9
43	41 7	10 4	03	99 9	25 0	63	158 1	39 6	23	216 3	54 2
44	42 7	10 7	04	100 9	25 3	64	159 1	39 8	24	217 3	54 4
45	43 7	10 9	05	101 9	25 5	65	160 1	40 1	25	218 3	54 7
46	44 6	11 2	06	102 8	25 8	66	161 0	40 3	26	219 2	54 9
47	45 6	11 4	07	103 8	26 0	67	162 0	40 6	27	220 2	55 2
48	46 6	11 7	08	104 6	26 2	68	163 0	40 8	28	221 2	55 4
49	47 5	11 9	09	105 7	26 5	69	163 9	41 1	29	222 1	55 6
50	48 5	12 1	10	106 7	26 7	70	164 9	41 3	30	223 1	55 9
51	49 5	12 4	11	107 7	27 0	71	165 9	41 5	231	224 1	56 1
52	50 4	12 6	12	108 6	27 2	72	166 8	41 8	32	225 0	56 4
53	51 4	12 9	13	109 6	27 5	73	167 8	42 0	33	226 0	56 6
54	52 4	13 1	14	110 6	27 7	74	168 8	42 3	34	227 0	56 9
55	53 4	13 4	15	111 6	27 9	75	169 8	42 5	35	228 0	57 1
56	54 3	13 6	16	112 5	28 2	76	170 7	42 8	36	228 9	57 3
57	55 3	13 8	17	113 5	28 4	77	171 7	43 0	37	229 9	57 6
58	56 3	14 1	18	114 5	28 7	78	172 7	43 3	38	230 9	57 8
59	57 2	14 3	19	115 4	28 9	79	173 6	43 5	39	231 8	58 1
60	58 2	14 6	20	116 4	29 2	80	174 6	43 7	40	232 8	58 3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N. by E. ½ E.			S. by E. ½ E.			W. by N. ½ W.			W. by S. ½ W.		
									(For 6 Points.)		

TABLE I.

Difference of Latitude and Departure for 1 $\frac{1}{2}$ Points.

N.b.E.4E.			N.b.W.4W.			S.b.E.4E.			S.b.W.4W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.4	17.7	181	115.8	35.1	181	173.2	52.8	241	230.6	70.0
2	01.9	00.6	62	59.3	18.0	22	116.7	35.4	182	174.2	52.8	42	231.6	70.2
3	02.9	00.9	63	60.3	18.3	23	117.7	35.7	83	175.1	53.1	83	232.5	70.5
4	03.8	01.2	64	61.2	18.6	24	118.7	36.0	84	176.1	53.4	84	233.5	70.8
5	04.8	01.5	65	62.2	18.9	25	119.6	36.3	85	177.0	53.7	45	234.5	71.1
6	05.7	01.7	66	63.2	19.2	26	120.6	36.6	86	178.0	54.0	46	235.4	71.4
7	06.7	02.0	67	64.1	19.4	27	121.5	36.9	87	178.9	54.3	47	236.4	71.7
8	07.7	02.3	68	65.1	19.7	28	122.5	37.2	88	179.9	54.6	88	237.3	72.0
9	08.6	02.6	69	66.0	20.0	29	123.4	37.4	89	180.9	54.9	49	238.3	72.3
10	09.6	02.9	70	67.0	20.3	30	124.4	37.7	90	181.8	55.2	50	239.2	72.6
11	10.5	03.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.9
12	11.5	03.5	72	68.9	20.9	32	126.3	38.3	92	183.7	55.7	62	241.1	73.2
13	12.4	03.8	73	69.9	21.2	33	127.3	38.6	93	184.7	56.0	63	242.1	73.4
14	13.4	04.1	74	70.8	21.5	34	128.2	38.9	94	185.6	56.3	64	243.1	73.7
15	14.4	04.4	75	71.8	21.8	35	129.2	39.2	95	186.6	56.6	65	244.0	74.0
16	15.3	04.6	76	72.7	22.1	36	130.1	39.5	96	187.6	56.9	66	245.0	74.3
17	16.3	04.9	77	73.7	22.4	37	131.1	39.8	97	188.5	57.2	67	245.9	74.6
18	17.2	05.2	78	74.6	22.6	38	132.1	40.1	98	189.5	57.5	68	246.9	74.9
19	18.2	05.5	79	75.6	22.9	39	133.0	40.3	99	190.4	57.8	69	247.8	75.2
20	19.1	05.8	80	76.6	23.2	40	134.0	40.6	200	191.4	58.1	60	248.8	75.5
21	20.1	06.1	81	77.5	23.5	141	134.9	40.9	201	192.3	58.3	261	249.8	75.8
22	21.1	06.4	82	78.5	23.8	42	135.9	41.2	02	193.3	58.6	62	250.7	76.1
23	22.0	06.7	83	79.4	24.1	43	136.8	41.5	03	194.3	58.9	63	251.7	76.3
24	23.0	07.0	84	80.4	24.4	44	137.8	41.8	04	195.2	59.2	64	252.6	76.6
25	23.9	07.3	85	81.3	24.7	45	138.8	42.1	05	196.2	59.5	65	253.6	76.9
26	24.9	07.5	86	82.3	25.0	46	139.7	42.4	06	197.1	59.8	66	254.5	77.2
27	25.8	07.8	87	83.3	25.3	47	140.7	42.7	07	198.1	60.1	67	255.5	77.5
28	26.8	08.1	88	84.2	25.5	48	141.6	43.0	08	199.0	60.4	68	256.5	77.8
29	27.8	08.4	89	85.2	25.8	49	142.6	43.3	09	200.0	60.7	69	257.4	78.1
30	28.7	08.7	90	86.1	26.1	50	143.5	43.5	10	201.0	61.0	70	258.4	78.4
31	29.7	09.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.3	271	259.3	78.7
32	30.6	09.3	92	88.0	26.7	52	145.5	44.1	12	202.9	61.6	72	260.3	79.0
33	31.6	09.6	93	89.0	27.0	53	146.4	44.4	13	203.8	61.8	73	261.2	79.3
34	32.5	09.9	94	90.0	27.3	54	147.4	44.7	14	204.8	62.1	74	262.2	79.5
35	33.5	10.2	95	90.9	27.6	55	148.3	45.0	15	205.7	62.4	75	263.2	79.8
36	34.4	10.5	96	91.9	27.9	56	149.3	45.3	16	206.7	62.7	76	264.1	80.1
37	35.4	10.7	97	92.8	28.2	57	150.2	45.6	17	207.7	63.0	77	265.1	80.4
38	36.4	11.0	98	93.8	28.4	58	151.2	45.9	18	208.6	63.3	78	266.0	80.7
39	37.3	11.3	99	94.7	28.7	59	152.2	46.2	19	209.6	63.6	79	267.0	81.0
40	38.3	11.6	100	95.7	29.0	60	153.1	46.4	20	210.5	63.9	80	267.9	81.3
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.2	281	268.9	81.6
42	40.2	12.2	02	97.6	29.6	62	155.0	47.0	22	212.4	64.4	82	269.9	81.9
43	41.1	12.5	03	98.6	29.9	63	156.0	47.3	23	213.4	64.7	83	270.8	82.2
44	42.1	12.8	04	99.5	30.2	64	156.9	47.6	24	214.4	65.0	84	271.8	82.4
45	43.1	13.1	05	100.5	30.5	65	157.9	47.9	25	215.3	65.3	85	272.7	82.7
46	44.0	13.4	06	101.4	30.8	66	158.9	48.2	26	216.3	65.6	86	273.7	83.0
47	45.0	13.6	07	102.4	31.1	67	159.8	48.5	27	217.2	65.9	87	274.6	83.3
48	45.9	13.9	08	103.3	31.4	68	160.8	48.8	28	218.2	66.2	88	275.6	83.6
49	46.9	14.2	09	104.3	31.6	69	161.7	49.1	29	219.1	66.5	89	276.6	83.9
50	47.8	14.5	10	105.3	31.9	70	162.7	49.3	30	220.1	66.8	90	277.5	84.2
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.1	291	278.5	84.5
52	49.8	15.1	12	107.2	32.5	72	164.6	49.9	32	222.0	67.3	92	279.4	84.8
53	50.7	15.4	13	108.1	32.8	73	165.6	50.2	33	223.0	67.6	93	280.4	85.1
54	51.7	15.7	14	109.1	33.1	74	166.5	50.5	34	223.9	67.9	94	281.3	85.3
55	52.6	16.0	15	110.0	33.4	75	167.5	50.8	35	224.9	68.2	95	282.3	85.6
56	53.6	16.3	16	111.0	33.7	76	168.4	51.1	36	225.8	68.5	96	283.3	85.9
57	54.5	16.5	17	112.0	34.0	77	169.4	51.4	37	226.8	68.8	97	284.2	86.2
58	55.5	16.8	18	112.9	34.3	78	170.3	51.7	38	227.8	69.1	98	285.2	86.5
59	56.5	17.1	19	113.9	34.5	79	171.3	52.0	39	228.7	69.4	99	286.1	86.8
60	57.4	17.4	20	114.8	34.8	80	172.2	52.3	40	229.7	69.7	200	287.1	87.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.4E.			E.S.E.4E.			W.N.W.4W.			W.S.W.4W.			For 6 Points.		

TABLE I.

7

Difference of Latitude and Departure for 14 Points.

N.b.E.½E.			N.b.W.½W.			S.b.E.½E.			S.b.W.½W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 3	61	57 4	30 6	121	113 9	40 8	181	170 4	61 0
2	01 9	00 7	62	58 4	30 9	122	114 9	41 1	182	171 4	61 3
3	02 8	01 0	63	59 3	31 2	123	115 8	41 4	183	172 3	61 7
4	03 8	01 3	64	60 3	31 6	124	116 8	41 8	184	173 2	62 0
5	04 7	01 7	65	61 2	31 9	125	117 7	42 1	185	174 2	62 3
6	05 6	02 0	66	62 1	32 2	126	118 6	42 4	186	175 1	62 7
7	06 6	02 4	67	63 1	32 6	127	119 6	42 8	187	176 1	63 0
8	07 5	02 7	68	64 0	32 9	128	120 5	43 1	188	177 0	63 3
9	08 5	03 0	69	65 0	33 2	129	121 5	43 5	189	178 0	63 7
10	09 4	03 4	70	65 9	33 5	130	122 4	43 8	190	178 9	64 0
11	10 4	03 7	71	66 8	33 9	131	123 3	44 1	191	179 8	64 3
12	11 3	04 0	72	67 8	34 3	132	124 3	44 5	192	180 8	64 7
13	12 2	04 4	73	68 7	34 6	133	125 2	44 8	193	181 7	65 0
14	13 2	04 7	74	69 7	34 9	134	126 2	45 1	194	182 7	65 4
15	14 1	05 1	75	70 6	35 3	135	127 1	45 5	195	183 6	65 7
16	15 1	05 4	76	71 6	35 6	136	128 0	45 8	196	184 5	66 0
17	16 0	05 7	77	72 5	35 9	137	129 0	46 2	197	185 5	66 4
18	16 9	06 1	78	73 4	36 3	138	129 9	46 5	198	186 4	66 7
19	17 9	06 4	79	74 4	36 6	139	130 9	46 8	199	187 4	67 0
20	18 8	06 7	80	75 3	37 0	140	131 8	47 2	200	188 3	67 4
21	19 8	07 1	81	76 3	37 3	141	132 8	47 5	201	189 3	67 7
22	20 7	07 4	82	77 2	37 6	142	133 7	47 8	202	190 2	68 1
23	21 7	07 7	83	78 1	38 0	143	134 6	48 2	203	191 1	68 4
24	22 6	08 1	84	79 1	38 3	144	135 6	48 5	204	192 1	68 7
25	23 5	08 4	85	80 0	38 6	145	136 5	48 8	205	193 0	69 1
26	24 5	08 8	86	81 0	39 0	146	137 5	49 2	206	194 0	69 4
27	25 4	09 1	87	81 9	39 3	147	138 4	49 5	207	194 9	69 7
28	26 4	09 4	88	82 9	39 6	148	139 3	49 9	208	195 8	70 1
29	27 3	09 8	89	83 8	39 0	149	140 3	50 2	209	196 8	70 4
30	28 2	10 1	90	84 7	39 3	150	141 2	50 5	210	197 7	70 7
31	29 2	10 4	91	85 7	39 7	151	142 2	50 9	211	198 7	71 1
32	30 1	10 8	92	86 6	39 0	152	143 1	51 2	212	199 6	71 4
33	31 1	11 1	93	87 6	39 3	153	144 1	51 5	213	200 5	71 8
34	32 0	11 4	94	88 5	39 7	154	145 0	51 9	214	201 5	72 1
35	33 0	11 8	95	89 4	39 0	155	145 9	52 2	215	202 4	72 4
36	33 9	12 1	96	90 4	39 3	156	146 9	52 6	216	203 4	72 8
37	34 8	12 5	97	91 3	39 7	157	147 8	52 9	217	204 3	73 1
38	35 7	12 8	98	92 3	39 0	158	148 8	53 2	218	205 3	73 4
39	36 7	13 1	99	93 2	39 4	159	149 7	53 6	219	206 2	73 8
40	37 7	13 5	100	94 2	39 7	160	150 6	53 9	220	207 1	74 1
41	38 6	13 8	101	95 1	34 0	161	151 6	54 2	221	208 1	74 5
42	39 5	14 1	102	96 0	34 4	162	152 5	54 6	222	209 0	74 8
43	40 5	14 5	103	97 0	34 7	163	153 5	54 9	223	210 0	75 1
44	41 4	14 8	104	97 9	35 0	164	154 4	55 2	224	210 9	75 5
45	42 4	15 2	105	98 9	35 4	165	155 4	55 6	225	211 8	75 8
46	43 3	15 5	106	99 8	35 7	166	156 3	55 9	226	212 8	76 1
47	44 3	15 8	107	100 7	36 0	167	157 2	56 3	227	213 7	76 5
48	45 2	16 2	108	101 7	36 4	168	158 2	56 6	228	214 7	76 8
49	46 1	16 5	109	102 6	36 7	169	159 1	56 9	229	215 6	77 1
50	47 1	16 8	110	103 6	37 1	170	160 1	57 3	230	216 6	77 5
51	48 0	17 2	111	104 5	37 4	171	161 0	57 6	231	217 5	77 8
52	49 0	17 5	112	105 5	37 7	172	161 9	57 9	232	218 4	78 2
53	49 9	17 9	113	106 4	38 1	173	162 9	58 3	233	219 4	78 5
54	50 8	18 2	114	107 3	38 4	174	163 8	58 6	234	220 3	78 8
55	51 8	18 5	115	108 3	38 7	175	164 8	59 0	235	221 3	79 2
56	52 7	18 9	116	109 2	39 1	176	165 7	59 3	236	222 2	79 5
57	53 7	19 2	117	110 2	39 4	177	166 7	59 6	237	223 1	79 8
58	54 6	19 5	118	111 1	39 8	178	167 6	60 0	238	224 1	80 2
59	55 6	19 9	119	112 0	40 1	179	168 5	60 3	239	225 0	80 5
60	56 5	20 2	120	113 0	40 4	180	169 5	60 6	240	226 0	80 9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.b.E.½E.			N.b.W.½W.			S.b.E.½E.			S.b.W.½W.		
									For 14 Points.		

TABLE I.

Difference of Latitude and Departure for 2 Points.

N.N.E.			N.N.W.			S.S.E.			S.S.W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 4	61	56 4	23 3	121	111 8	46 3	181	167 2	69 3
2	01 8	00 8	62	57 3	23 7	22	112 7	46 7	82	168 1	69 6
3	02 8	01 1	63	58 2	24 1	23	113 6	47 1	83	169 1	70 0
4	03 7	01 5	64	59 1	24 5	24	114 6	47 5	84	170 0	70 4
5	04 6	01 9	65	60 1	24 9	25	115 5	47 8	85	170 9	70 8
6	05 5	02 3	66	61 0	25 3	26	116 4	48 2	86	171 8	71 2
7	06 5	02 7	67	61 9	25 6	27	117 3	48 6	87	172 8	71 6
8	07 4	03 1	68	62 8	26 0	28	118 3	49 0	88	173 7	71 9
9	08 3	03 4	69	63 7	26 4	29	119 2	49 4	89	174 6	72 3
10	09 2	03 8	70	64 7	26 8	30	120 1	49 7	90	175 5	72 7
11	10 2	04 2	71	65 6	27 2	131	121 0	50 1	191	176 5	73 1
12	11 1	04 6	72	66 5	27 6	32	122 0	50 5	92	177 4	73 5
13	12 0	05 0	73	67 4	27 9	33	122 9	50 9	93	178 3	73 9
14	12 9	05 4	74	68 4	28 3	34	123 8	51 3	94	179 2	74 2
15	13 9	05 7	75	69 3	28 7	35	124 7	51 7	95	180 2	74 6
16	14 8	06 1	76	70 2	29 1	36	125 6	52 0	96	181 1	75 0
17	15 7	06 5	77	71 1	29 5	37	126 6	52 4	97	182 0	75 4
18	16 6	06 9	78	72 1	29 8	38	127 5	52 7	98	182 9	75 8
19	17 5	07 3	79	73 0	30 2	39	128 4	53 2	99	183 9	76 2
20	18 5	07 7	80	73 9	30 6	40	129 3	53 6	200	184 8	76 5
21	19 4	08 0	81	74 8	31 0	141	130 3	54 0	201	185 7	76 9
22	20 3	08 4	82	75 8	31 4	42	131 2	54 3	02	186 6	77 3
23	21 2	08 8	83	76 7	31 8	43	132 1	54 7	03	187 5	77 7
24	22 2	09 2	84	77 6	32 1	44	133 0	55 1	04	188 5	78 1
25	23 1	09 6	85	78 5	32 5	45	134 0	55 5	05	189 4	78 5
26	24 0	09 9	86	79 5	32 9	46	134 9	55 9	06	190 3	78 8
27	24 9	10 3	87	80 4	33 3	47	135 8	56 3	07	191 2	79 2
28	25 9	10 7	88	81 3	33 7	48	136 7	56 6	08	192 2	79 6
29	26 8	11 1	89	82 2	34 1	49	137 7	57 0	09	193 1	80 0
30	27 7	11 5	90	83 1	34 5	50	138 6	57 4	10	194 0	80 4
31	28 6	11 9	91	84 1	34 9	151	139 5	57 8	211	194 9	80 7
32	29 6	12 2	92	85 0	35 2	52	140 4	58 2	12	195 9	81 1
33	30 5	12 6	93	85 9	35 6	53	141 4	58 6	13	196 8	81 5
34	31 4	13 0	94	86 8	36 0	54	142 3	58 9	14	197 7	81 9
35	32 3	13 4	95	87 8	36 4	55	143 2	59 3	15	198 6	82 3
36	33 3	13 8	96	88 7	36 7	56	144 1	59 7	16	199 6	82 7
37	34 2	14 2	97	89 6	37 1	57	145 0	60 1	17	200 5	83 0
38	35 1	14 5	98	90 5	37 5	58	146 0	60 5	18	201 4	83 4
39	36 0	14 9	99	91 5	37 9	59	146 9	60 9	19	202 3	83 8
40	37 0	15 3	100	92 4	38 3	60	147 8	61 2	20	203 3	84 2
41	37 9	15 7	101	93 3	38 7	161	148 7	61 6	211	204 2	84 6
42	38 8	16 1	02	94 2	39 0	62	149 7	62 0	22	205 1	85 0
43	39 7	16 5	03	95 2	39 4	63	150 6	62 4	23	206 0	85 3
44	40 7	16 8	04	96 1	39 8	64	151 5	62 8	24	206 9	85 7
45	41 6	17 2	05	97 0	40 2	65	152 4	63 1	25	207 9	86 1
46	42 5	17 6	06	97 9	40 6	66	153 4	63 5	26	208 8	86 5
47	43 4	18 0	07	98 9	40 9	67	154 3	63 9	27	209 7	86 9
48	44 3	18 4	08	99 8	41 3	68	155 2	64 3	28	210 6	87 3
49	45 3	18 8	09	100 7	41 7	69	156 1	64 7	29	211 6	87 6
50	46 2	19 1	10	101 6	42 1	70	157 1	65 1	30	212 5	88 0
51	47 1	19 5	111	102 6	42 5	171	158 0	65 4	211	213 4	88 4
52	48 0	19 9	12	103 5	42 9	72	158 9	65 8	32	214 3	88 8
53	49 0	20 3	13	104 4	43 2	73	159 8	66 2	33	215 3	89 2
54	49 9	20 7	14	105 3	43 6	74	160 8	66 6	34	216 2	89 5
55	50 8	21 0	15	106 2	44 0	75	161 7	67 0	35	217 1	89 9
56	51 7	21 4	16	107 2	44 4	76	162 6	67 4	36	218 0	90 3
57	52 7	21 8	17	108 1	44 8	77	163 5	67 7	37	219 0	90 7
58	53 6	22 2	18	109 0	45 2	78	164 5	68 1	38	219 9	91 1
59	54 5	22 6	19	109 9	45 6	79	165 4	68 5	39	220 8	91 5
60	55 4	23 0	20	110 9	45 9	80	166 3	68 9	40	221 7	91 8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.			E.S.E.			W.N.W.			W.S.W.		

(For 6 Points.)

TABLE I.

9

Difference of Latitude and Departure for 2½ Points.

N.N.E.½E.			N.N.W.½W.			S.S.E.½E.			S.S.W.½W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4
2	01.8	00.9	62	56.0	26.5	22	110.3	52.2	82	164.5	77.8
3	02.7	01.3	63	57.0	26.9	23	111.2	52.6	83	165.4	78.2
4	03.6	01.7	64	57.9	27.4	24	112.1	53.0	84	166.3	78.7
5	04.5	02.1	65	58.8	27.8	25	113.0	53.4	85	167.2	79.1
6	05.4	02.6	66	59.7	28.2	26	113.9	53.9	86	168.1	79.5
7	06.3	03.0	67	60.6	28.6	27	114.8	54.3	87	169.0	80.0
8	07.2	03.4	68	61.5	29.1	28	115.7	54.7	88	169.9	80.4
9	08.1	03.8	69	62.4	29.5	29	116.6	55.2	89	170.8	80.8
10	09.0	04.3	70	63.3	29.9	30	117.5	55.6	90	171.7	81.2
11	09.9	04.7	71	64.2	30.4	131	118.4	56.0	191	172.7	81.7
12	10.8	05.1	72	65.1	30.8	32	119.3	56.4	92	173.6	82.1
13	11.8	05.6	73	66.0	31.2	33	120.2	56.9	93	174.5	82.5
14	12.7	06.0	74	66.9	31.6	34	121.1	57.3	94	175.4	82.9
15	13.6	06.4	75	67.8	32.1	35	122.0	57.7	95	176.3	83.4
16	14.5	06.8	76	68.7	32.5	36	122.9	58.1	96	177.2	83.8
17	15.4	07.3	77	69.6	32.9	37	123.8	58.6	97	178.1	84.2
18	16.3	07.7	78	70.5	33.3	38	124.8	59.0	98	179.0	84.7
19	17.2	08.1	79	71.4	33.8	39	125.7	59.4	99	179.9	85.1
20	18.1	08.6	80	72.3	34.2	40	126.6	59.9	200	180.8	85.5
21	19.0	09.0	81	73.2	34.6	111	127.5	60.3	201	181.7	85.9
22	19.9	09.4	82	74.1	35.1	42	128.4	60.7	02	182.6	86.4
23	20.8	09.8	83	75.0	35.5	43	129.3	61.1	03	183.5	86.8
24	21.7	10.3	84	75.9	35.9	44	130.2	61.6	04	184.4	87.2
25	22.6	10.7	85	76.8	36.3	45	131.1	62.0	05	185.3	87.6
26	23.5	11.1	86	77.7	36.8	46	132.0	62.4	06	186.2	88.1
27	24.4	11.5	87	78.6	37.2	47	132.9	62.9	07	187.1	88.5
28	25.3	12.0	88	79.6	37.6	48	133.8	63.3	08	188.0	88.9
29	26.2	12.4	89	80.5	38.1	49	134.7	63.7	09	188.9	89.4
30	27.1	12.8	90	81.4	38.5	50	135.6	64.1	10	189.8	89.8
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2
32	28.9	13.7	92	83.2	39.3	52	137.4	65.0	12	191.6	90.6
33	29.8	14.1	93	84.1	39.8	53	138.3	65.4	13	192.5	91.1
34	30.7	14.5	94	85.0	40.2	54	139.2	65.8	14	193.4	91.5
35	31.6	15.0	95	85.9	40.6	55	140.1	66.3	15	194.3	91.9
36	32.5	15.4	96	86.8	41.0	56	141.0	66.7	16	195.2	92.4
37	33.4	15.8	97	87.7	41.5	57	141.9	67.1	17	196.1	92.8
38	34.3	16.2	98	88.6	41.9	58	142.8	67.6	18	197.0	93.2
39	35.2	16.7	99	89.5	42.3	59	143.7	68.0	19	197.9	93.6
40	36.1	17.1	100	90.4	42.8	60	144.6	68.4	20	198.8	94.1
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.7	94.5
42	38.0	18.0	02	92.2	43.6	62	146.4	69.3	22	200.6	94.9
43	38.9	18.4	03	93.1	44.0	63	147.3	69.7	23	201.5	95.3
44	39.8	18.8	04	94.0	44.5	64	148.2	70.1	24	202.4	95.8
45	40.7	19.2	05	94.9	44.9	65	149.1	70.6	25	203.3	96.2
46	41.6	19.7	06	95.8	45.3	66	150.0	71.0	26	204.2	96.6
47	42.5	20.1	07	96.7	45.7	67	150.9	71.4	27	205.1	97.1
48	43.4	20.5	08	97.6	46.2	68	151.8	71.8	28	206.0	97.5
49	44.3	21.0	09	98.5	46.6	69	152.7	72.3	29	206.9	97.9
50	45.2	21.4	10	99.4	47.0	70	153.6	72.7	30	207.8	98.3
51	46.1	21.8	111	100.3	47.5	171	154.5	73.1	231	208.7	98.8
52	47.0	22.2	12	101.2	47.9	72	155.4	73.5	32	209.6	99.2
53	47.9	22.7	13	102.1	48.3	73	156.3	74.0	33	210.5	99.6
54	48.8	23.1	14	103.0	48.7	74	157.2	74.4	34	211.4	100.0
55	49.7	23.5	15	103.9	49.2	75	158.1	74.8	35	212.3	100.5
56	50.6	23.9	16	104.8	49.6	76	159.0	75.2	36	213.2	100.9
57	51.5	24.4	17	105.7	50.0	77	160.0	75.7	37	214.1	101.3
58	52.4	24.8	18	106.6	50.5	78	160.9	76.1	38	215.0	101.8
59	53.3	25.2	19	107.5	50.9	79	161.8	76.5	39	215.9	102.2
60	54.2	25.7	20	108.4	51.3	80	162.7	77.0	40	216.8	102.6
61	55.1	26.1	21	109.3	51.7	81	163.6	77.4	41	217.7	103.0
62	56.0	26.5	22	110.2	52.2	82	164.5	77.8	42	218.6	103.5
63	57.0	26.9	23	111.1	52.6	83	165.4	78.2	43	219.5	103.9
64	57.9	27.4	24	112.0	53.0	84	166.3	78.7	44	220.4	104.3
65	58.8	27.8	25	112.9	53.4	85	167.2	79.1	45	221.3	104.8
66	59.7	28.2	26	113.8	53.9	86	168.1	79.5	46	222.2	105.2
67	60.6	28.6	27	114.7	54.3	87	169.0	80.0	47	223.1	105.6
68	61.5	29.1	28	115.6	54.7	88	169.9	80.4	48	224.0	106.0
69	62.4	29.5	29	116.5	55.2	89	170.8	80.8	49	224.9	106.5
70	63.3	29.9	30	117.4	55.6	90	171.7	81.2	50	225.8	106.9
71	64.2	30.4	31	118.3	56.0	191	172.6	81.7	251	226.7	107.3
72	65.1	30.8	32	119.2	56.4	92	173.6	82.1	52	227.6	107.7
73	66.0	31.2	33	120.1	56.9	93	174.5	82.5	53	228.5	108.2
74	66.9	31.6	34	121.0	57.3	94	175.4	82.9	54	229.4	108.6
75	67.8	32.1	35	121.9	57.7	95	176.3	83.4	55	230.3	109.0
76	68.7	32.5	36	122.8	58.1	96	177.2	83.8	56	231.2	109.5
77	69.6	32.9	37	123.7	58.6	97	178.1	84.2	57	232.1	109.9
78	70.5	33.3	38	124.6	59.0	98	179.0	84.7	58	233.0	110.3
79	71.4	33.8	39	125.5	59.4	99	179.9	85.1	59	233.9	110.7
80	72.3	34.2	40	126.4	59.9	200	180.8	85.5	60	234.8	111.2
81	73.2	34.6	41	127.3	60.3	201	181.7	85.9	261	235.7	111.6
82	74.1	35.1	42	128.2	60.7	02	182.6	86.4	62	236.6	112.0
83	75.0	35.5	43	129.1	61.1	03	183.5	86.8	63	237.5	112.4
84	75.9	35.9	44	130.0	61.6	04	184.4	87.2	64	238.4	112.9
85	76.8	36.3	45	130.9	62.0	05	185.3	87.6	65	239.3	113.3
86	77.7	36.8	46	131.8	62.4	06	186.2	88.1	66	240.2	113.7
87	78.6	37.2	47	132.7	62.9	07	187.1	88.5	67	241.1	114.2
88	79.5	37.6	48	133.6	63.3	08	188.0	88.9	68	242.0	114.6
89	80.4	38.1	49	134.5	63.7	09	188.9	89.4	69	242.9	115.0
90	81.3	38.5	50	135.4	64.1	10	189.8	89.8	70	243.8	115.4
91	82.2	38.9	51	136.3	64.6	211	190.7	90.2	271	244.7	115.8
92	83.1	39.3	52	137.2	65.0	12	191.6	90.6	72	245.6	116.3
93	84.0	39.8	53	138.1	65.4	13	192.5	91.1	73	246.5	116.7
94	84.9	40.2	54	139.0	65.8	14	193.4	91.5	74	247.4	117.2
95	85.8	40.6	55	139.9	66.3	15	194.3	91.9	75	248.3	117.6
96	86.7	41.0	56	140.8	66.7	16	195.2	92.4	76	249.2	118.0
97	87.6	41.5	57	141.7	67.1	17	196.1	92.8	77	250.1	118.4
98	88.5	41.9	58	142.6	67.6	18	197.0	93.2	78	251.0	118.9
99	89.4	42.3	59	143.5	68.0	19	197.9	93.6	79	251.9	119.3
100	90.3	42.8	60	144.4	68.4	20	198.8	94.1	80	252.8	119.7
101	91.2	43.2	61	145.3	68.8	221	199.7	94.5	281	253.7	120.1
102	92.1	43.6	62	146.2	69.3	22	200.6	94.9	82	254.6	120.6
103	93.0	44.0	63	147.1	69.7	23	201.5	95.3	83	255.5	121.0
104	93.9	44.5	64	148.0	70.1	24	202.4	95.8	84	256.4	121.4
105	94.8	44.9	65	148.9	70.6	25	203.3	96.2	85	257.3	121.9
106	95.7	45.3	66	149.8	71.0	26	204.2	96.6	86	258.2	122.3
107	96.6	45.7	67	150.7	71.4	27	205.1	97.1	87	259.1	122.7
108	97.5	46.2	68	151.6	71.8	28	206.0	97.5	88	260.0	123.1
109	98.4	46.6	69	152.5	72.3	29	206.9	97.9	89	260.9	123.6
110	99.3	47.0	70	153.4	72.7	30	207.8	98.3	90	261.8	124.0
111	100.2	47.5	71	154.3	73.1	231	208.7	98.8	291	262.7	12

TABLE I.

Difference of Latitude and Departure for 2½ Points.

N N E ¼ E.			N N W ¼ W.			S S E ¼ E.			S S W ¼ W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.8	61	53.8	23.8	121	106.7	57.0	181	159.6	83.3
2	01.4	00.9	62	54.7	29.2	22	107.6	57.5	82	160.3	83.8
3	02.6	01.4	63	55.6	29.7	23	108.5	58.0	83	161.4	86.3
4	03.5	01.9	64	56.4	30.2	24	109.4	58.5	84	162.3	86.7
5	04.4	02.4	65	57.3	30.6	25	110.2	59.0	85	163.2	87.2
6	05.3	02.8	66	58.2	31.1	26	111.1	59.4	86	164.0	87.7
7	06.2	03.3	67	59.1	31.6	27	112.0	59.9	87	164.9	88.2
8	07.1	03.8	68	60.0	32.1	28	112.9	60.3	88	165.8	88.6
9	07.9	04.2	69	60.9	32.6	29	113.8	60.8	89	166.7	89.1
10	08.8	04.7	70	61.7	33.0	30	114.6	61.3	90	167.6	89.6
11	09.7	05.2	71	62.6	33.5	31	115.5	61.8	91	168.4	90.0
12	10.6	05.7	72	63.5	33.9	32	116.4	62.2	92	169.3	90.5
13	11.5	06.1	73	64.4	34.4	33	117.3	62.7	93	170.2	91.0
14	12.3	06.6	74	65.3	34.9	34	118.2	63.2	94	171.1	91.5
15	13.2	07.1	75	66.1	35.4	35	119.1	63.6	95	172.0	91.9
16	14.1	07.5	76	67.0	35.8	36	119.9	64.1	96	172.9	92.4
17	15.0	08.0	77	67.9	36.3	37	120.8	64.6	97	173.7	92.9
18	15.9	08.5	78	68.8	36.8	38	121.7	65.1	98	174.6	93.3
19	16.8	09.0	79	69.7	37.2	39	122.6	65.6	99	175.5	93.8
20	17.6	09.4	80	70.6	37.7	40	123.5	66.0	100	176.4	94.3
21	18.5	09.9	81	71.5	38.2	41	124.4	66.5	201	177.3	94.8
22	19.4	10.4	82	72.4	38.7	42	125.2	66.9	02	178.1	95.2
23	20.3	10.8	83	73.3	39.1	43	126.1	67.4	03	179.0	95.7
24	21.2	11.3	84	74.1	39.6	44	127.0	67.9	04	179.9	96.2
25	22.0	11.8	85	75.0	40.1	45	127.9	68.4	05	180.8	96.6
26	22.9	12.3	86	75.8	40.5	46	128.8	68.8	06	181.7	97.1
27	23.8	12.7	87	76.7	41.0	47	129.6	69.3	07	182.6	97.6
28	24.7	13.2	88	77.6	41.5	48	130.5	69.8	08	183.4	98.1
29	25.6	13.7	89	78.5	42.0	49	131.4	70.2	09	184.3	98.5
30	26.5	14.1	90	79.4	42.4	50	132.3	70.7	10	185.2	99.0
31	27.3	14.6	91	80.3	42.9	51	133.2	71.2	21	186.1	99.5
32	28.2	15.1	92	81.1	43.4	52	134.1	71.7	12	187.0	99.9
33	29.1	15.6	93	82.0	43.8	53	134.9	72.1	13	187.8	100.4
34	30.0	16.0	94	82.9	44.3	54	135.8	72.6	14	188.7	100.9
35	30.9	16.5	95	83.8	44.8	55	136.7	73.1	15	189.6	101.4
36	31.7	17.0	96	84.7	45.3	56	137.6	73.6	16	190.5	101.8
37	32.6	17.4	97	85.6	45.7	57	138.5	74.0	17	191.4	102.3
38	33.5	17.9	98	86.5	46.2	58	139.3	74.5	18	192.3	102.8
39	34.4	18.4	99	87.4	46.7	59	140.2	75.0	19	193.2	103.2
40	35.3	18.9	100	88.3	47.1	60	141.1	75.4	20	194.0	103.7
41	36.2	19.3	101	89.1	47.6	61	142.0	75.9	21	194.9	104.2
42	37.0	19.8	02	90.0	48.1	62	142.9	76.4	22	195.8	104.7
43	37.9	20.3	03	90.8	48.6	63	143.8	76.8	23	196.7	105.1
44	38.8	20.7	04	91.7	49.0	64	144.6	77.3	24	197.6	105.6
45	39.7	21.2	05	92.6	49.5	65	145.5	77.7	25	198.5	106.1
46	40.6	21.7	06	93.5	50.0	66	146.4	78.2	26	199.3	106.5
47	41.5	22.2	07	94.4	50.4	67	147.3	78.7	27	200.2	107.0
48	42.3	22.6	08	95.2	50.9	68	148.2	79.2	28	201.1	107.5
49	43.2	23.1	09	96.1	51.4	69	149.0	79.7	29	202.0	107.9
50	44.1	23.6	10	97.0	51.9	70	149.9	80.1	30	202.8	108.4
51	45.0	24.0	11	97.9	52.3	71	150.8	80.6	231	203.7	108.9
52	45.9	24.5	12	98.8	52.8	72	151.7	81.1	32	204.6	109.4
53	46.7	25.0	13	99.7	53.3	73	152.6	81.6	33	205.5	109.8
54	47.6	25.5	14	100.5	53.7	74	153.5	82.0	34	206.4	110.3
55	48.5	25.9	15	101.4	54.2	75	154.3	82.5	35	207.3	110.8
56	49.4	26.4	16	102.3	54.7	76	155.2	83.0	36	208.1	111.2
57	50.3	26.9	17	103.2	55.2	77	156.1	83.4	37	209.0	111.7
58	51.2	27.3	18	104.1	55.6	78	157.0	83.9	38	209.9	112.2
59	52.0	27.8	19	104.9	56.1	79	157.9	84.4	39	210.8	112.7
60	52.9	28.3	20	105.8	56.6	80	158.7	84.9	40	211.7	113.1
61	53.8	28.8	21	106.7	57.0	81	159.6	85.3	241	212.5	113.6
62	54.7	29.2	22	107.6	57.5	82	160.5	85.8	42	213.4	114.1
63	55.6	29.7	23	108.5	58.0	83	161.4	86.3	43	214.3	114.5
64	56.4	30.2	24	109.4	58.5	84	162.3	86.7	44	215.2	115.0
65	57.3	30.6	25	110.2	59.0	85	163.2	87.2	45	216.1	115.5
66	58.2	31.1	26	111.1	59.4	86	164.0	87.7	46	217.0	116.0
67	59.1	31.6	27	112.0	59.9	87	164.9	88.2	47	217.8	116.4
68	60.0	32.1	28	112.9	60.3	88	165.8	88.6	48	218.7	116.9
69	60.9	32.6	29	113.8	60.8	89	166.7	89.1	49	219.6	117.4
70	61.7	33.0	30	114.6	61.3	90	167.6	89.6	50	220.5	117.8
71	62.6	33.5	31	115.5	61.8	91	168.4	90.0	251	221.4	118.3
72	63.5	33.9	32	116.4	62.2	92	169.3	90.5	52	222.3	118.8
73	64.4	34.4	33	117.3	62.7	93	170.2	91.0	53	223.2	119.3
74	65.3	34.9	34	118.2	63.2	94	171.1	91.5	54	224.1	119.7
75	66.1	35.4	35	119.1	63.6	95	172.0	91.9	55	225.0	120.2
76	67.0	35.8	36	119.9	64.1	96	172.9	92.4	56	225.9	120.7
77	67.9	36.3	37	120.8	64.6	97	173.7	92.9	57	226.8	121.1
78	68.8	36.8	38	121.7	65.1	98	174.6	93.3	58	227.7	121.6
79	69.7	37.2	39	122.6	65.6	99	175.5	93.8	59	228.6	122.1
80	70.6	37.7	40	123.5	66.0	100	176.4	94.3	60	229.5	122.6
81	71.5	38.2	41	124.4	66.5	201	177.3	94.8	261	230.4	123.0
82	72.4	38.7	42	125.2	66.9	02	178.1	95.2	62	231.3	123.5
83	73.3	39.1	43	126.1	67.4	03	179.0	95.7	63	232.2	124.0
84	74.1	39.6	44	127.0	67.9	04	179.9	96.2	64	233.1	124.4
85	75.0	40.1	45	127.9	68.4	05	180.8	96.6	65	234.0	124.9
86	75.8	40.5	46	128.8	68.8	06	181.7	97.1	66	234.9	125.4
87	76.7	41.0	47	129.6	69.3	07	182.6	97.6	67	235.8	125.9
88	77.6	41.5	48	130.5	69.8	08	183.4	98.1	68	236.7	126.4
89	78.5	42.0	49	131.4	70.2	09	184.3	98.5	69	237.6	126.8
90	79.4	42.4	50	132.3	70.7	10	185.2	99.0	70	238.5	127.3
91	80.3	42.9	51	133.2	71.2	21	186.1	99.5	271	239.4	127.7
92	81.1	43.4	52	134.1	71.7	12	187.0	99.9	72	240.3	128.2
93	82.0	43.8	53	134.9	72.1	13	187.8	100.4	73	241.2	128.7
94	82.9	44.3	54	135.8	72.6	14	188.7	100.9	74	242.1	129.2
95	83.8	44.8	55	136.7	73.1	15	189.6	101.4	75	243.0	129.6
96	84.7	45.3	56	137.6	73.6	16	190.5	101.8	76	243.9	130.1
97	85.6	45.7	57	138.5	74.0	17	191.4	102.3	77	244.8	130.6
98	86.5	46.2	58	139.3	74.5	18	192.3	102.8	78	245.7	131.1
99	87.4	46.7	59	140.2	75.0	19	193.2	103.2	79	246.6	131.5
100	88.3	47.1	60	141.1	75.4	20	194.0	103.7	80	247.5	132.0
101	89.1	47.6	61	142.0	75.9	21	194.9	104.2	281	248.4	132.5
102	90.0	48.1	62	142.9	76.4	22	195.8	104.7	82	249.3	133.0
103	90.8	48.6	63	143.8	76.8	23	196.7	105.1	83	250.2	133.5
104	91.7	49.0	64	144.6	77.3	24	197.6	105.6	84	251.1	134.0
105	92.6	49.5	65	145.5	77.7	25	198.5	106.1	85	252.0	134.5
106	93.5	50.0	66	146.4	78.2	26	199.3	106.5	86	252.9	135.0
107	94.4	50.4	67	147.3	78.7	27	200.2	107.0	87	253.8	135.5
108	95.2	50.9	68	148.2	79.2	28	201.1	107.5	88	254.7	136.0
109	96.1	51.4	69	149.0	79.7	29	202.0	107.9	89	255.6	136.5
110	97.0	51.9	70	149.9	80.1	30	202.8	108.4	90	256.5	137.0
111	97.9	52.3	71	150.8	80.6	231	203.7	10			

TABLE I.

11

Difference of Latitude and Departure for 24 Points.

N.N.E.½E.			N.N.W.¾W.			S.S.E.½E.			S.S.W.¾W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 5	61	52 3	31 4	121	103 8	62 2	181	153 2	93 1
2	01 7	01 0	62	53 2	31 9	122	104 6	62 7	182	156 1	93 6
3	02 6	01 5	63	54 0	32 4	123	105 5	63 2	183	157 0	94 1
4	03 4	02 1	64	54 9	32 9	124	106 4	63 7	184	157 8	94 6
5	04 3	02 6	65	55 8	33 1	125	107 2	64 3	185	158 7	95 1
6	05 1	03 1	66	56 6	33 9	126	108 1	64 8	186	159 5	95 6
7	06 0	03 6	67	57 5	34 1	127	108 9	65 3	187	160 4	96 1
8	06 9	04 1	68	58 3	35 0	128	109 8	65 8	188	161 3	96 7
9	07 7	04 6	69	59 2	35 5	129	110 6	66 3	189	162 1	97 2
10	08 6	05 1	70	60 0	36 0	130	111 5	66 8	190	163 0	97 7
11	09 4	05 7	71	60 9	36 5	131	112 4	67 3	191	163 8	98 2
12	10 3	06 2	72	61 8	37 0	132	113 2	67 9	192	164 7	98 7
13	11 2	06 7	73	62 6	37 5	133	114 1	68 4	193	165 5	99 2
14	12 0	07 2	74	63 5	38 0	134	114 9	68 9	194	166 4	99 7
15	12 9	07 7	75	64 3	38 6	135	115 8	69 4	195	167 3	100 3
16	13 7	08 2	76	65 2	39 1	136	116 7	69 9	196	168 1	100 8
17	14 6	08 7	77	66 0	39 6	137	117 5	70 4	197	169 0	101 3
18	15 4	09 3	78	66 9	40 1	138	118 4	70 9	198	169 8	101 8
19	16 3	09 8	79	67 8	40 6	139	119 2	71 5	199	170 7	102 3
20	17 2	10 3	80	68 6	41 1	140	120 1	72 0	200	171 5	102 8
21	18 0	10 8	81	69 5	41 6	141	120 9	72 5	201	172 4	103 3
22	18 9	11 3	82	70 3	42 2	142	121 8	73 0	202	173 3	103 8
23	19 7	11 8	83	71 2	42 7	143	122 7	73 5	203	174 1	104 4
24	20 6	12 3	84	72 0	43 2	144	123 5	74 0	204	175 0	104 9
25	21 4	12 9	85	72 9	43 7	145	124 4	74 5	205	175 8	105 4
26	22 3	13 4	86	73 8	44 2	146	125 2	75 1	206	176 7	105 9
27	23 2	13 9	87	74 6	44 7	147	126 1	75 6	207	177 5	106 4
28	24 0	14 4	88	75 5	45 2	148	126 9	76 1	208	178 4	106 9
29	24 9	14 9	89	76 3	45 7	149	127 8	76 6	209	179 3	107 4
30	25 7	15 4	90	77 2	46 3	150	128 7	77 1	210	180 1	107 9
31	26 6	15 9	91	78 1	46 8	151	129 5	77 6	211	181 0	108 4
32	27 4	16 5	92	78 9	47 3	152	130 4	78 1	212	181 8	108 9
33	28 3	17 0	93	79 8	47 8	153	131 2	78 7	213	182 7	109 4
34	29 2	17 5	94	80 6	48 3	154	132 1	79 2	214	183 5	109 9
35	30 0	18 0	95	81 5	48 8	155	132 9	79 7	215	184 4	110 4
36	30 9	18 5	96	82 3	49 3	156	133 8	80 2	216	185 3	110 9
37	31 7	19 0	97	83 2	49 8	157	134 7	80 7	217	186 1	111 4
38	32 6	19 5	98	84 1	50 3	158	135 5	81 2	218	187 0	111 9
39	33 5	20 1	99	84 9	50 8	159	136 4	81 7	219	187 8	112 4
40	34 3	20 6	100	85 8	51 3	160	137 2	82 3	220	188 7	112 9
41	35 2	21 1	101	86 6	51 8	161	138 1	82 8	221	189 5	113 4
42	36 0	21 6	102	87 5	52 3	162	139 0	83 3	222	190 4	113 9
43	36 9	22 1	103	88 3	52 8	163	139 8	83 8	223	191 3	114 4
44	37 7	22 6	104	89 2	53 3	164	140 7	84 3	224	192 1	114 9
45	38 6	23 1	105	90 1	53 8	165	141 5	84 8	225	193 0	115 4
46	39 5	23 6	106	90 9	54 3	166	142 4	85 3	226	193 8	115 9
47	40 3	24 1	107	91 8	54 8	167	143 2	85 8	227	194 7	116 4
48	41 2	24 6	108	92 6	55 3	168	144 1	86 3	228	195 5	116 9
49	42 0	25 1	109	93 5	55 8	169	145 0	86 8	229	196 4	117 4
50	42 9	25 6	110	94 4	56 3	170	145 8	87 3	230	197 3	117 9
51	43 7	26 1	111	95 2	56 8	171	146 7	87 8	231	198 1	118 4
52	44 6	26 6	112	96 1	57 3	172	147 5	88 3	232	199 0	118 9
53	45 5	27 1	113	96 9	57 8	173	148 4	88 8	233	199 8	119 4
54	46 3	27 6	114	97 8	58 3	174	149 2	89 3	234	200 7	119 9
55	47 2	28 1	115	98 6	58 8	175	150 1	89 8	235	201 5	120 4
56	48 0	28 6	116	99 5	59 3	176	151 0	90 3	236	202 4	120 9
57	48 9	29 1	117	100 3	59 8	177	151 8	90 8	237	203 3	121 4
58	49 7	29 6	118	101 2	60 3	178	152 7	91 3	238	204 1	121 9
59	50 6	30 1	119	102 1	60 8	179	153 5	91 8	239	205 0	122 4
60	51 5	30 6	120	102 9	61 3	180	154 4	92 3	240	205 8	122 9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.½E.			S.E.½E.			N.W.¾W.			S.W.¾W.		
									[For 5 Points]		

TABLE I.

Difference of Latitude and Departure for 3 Points.

N.E.b.N			N.W.b.N			S.E.b.S			S.W.b.S.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.7	33.9	121	100.0	67.2	181	150.0	100.5
2	01.7	01.1	62	51.6	34.4	22	101.4	67.8	82	151.3	101.1
3	02.5	01.7	63	52.4	35.0	23	102.3	68.3	83	152.2	101.7
4	03.3	02.2	64	53.2	35.6	24	103.1	68.9	84	153.0	102.2
5	04.2	02.8	65	54.0	36.1	25	103.9	69.4	85	153.8	102.8
6	05.0	03.3	66	54.9	36.7	26	104.8	70.0	86	154.7	103.3
7	05.8	03.9	67	55.7	37.2	27	105.6	70.5	87	155.5	103.9
8	06.7	04.4	68	56.5	37.8	28	106.4	71.1	88	156.3	104.4
9	07.5	05.0	69	57.4	38.3	29	107.3	71.7	89	157.1	105.0
10	08.3	05.6	70	58.2	38.9	30	108.1	72.2	90	158.0	105.5
11	09.1	06.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1
12	10.0	06.7	72	59.9	40.0	32	109.8	73.3	92	159.6	106.7
13	10.8	07.2	73	60.7	40.6	33	110.6	73.9	93	160.5	107.2
14	11.6	07.8	74	61.5	41.1	34	111.4	74.4	94	161.3	107.8
15	12.5	08.3	75	62.4	41.7	35	112.2	75.0	95	162.1	108.3
16	13.3	08.9	76	63.2	42.2	36	113.1	75.6	96	163.0	108.9
17	14.1	09.4	77	64.0	42.8	37	113.9	76.1	97	163.8	109.4
18	15.0	10.0	78	64.9	43.3	38	114.7	76.7	98	164.6	110.0
19	15.8	10.6	79	65.7	43.9	39	115.6	77.2	99	165.5	110.5
20	16.6	11.1	80	66.5	44.4	40	116.4	77.8	200	166.3	111.1
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7
22	18.3	12.2	82	68.2	45.6	42	118.1	78.9	02	168.0	112.2
23	19.1	12.8	83	69.0	46.1	43	118.9	79.4	03	168.8	112.8
24	20.0	13.3	84	69.8	46.7	44	119.7	80.0	04	169.6	113.3
25	20.8	13.9	85	70.7	47.2	45	120.6	80.5	05	170.5	113.9
26	21.6	14.4	86	71.5	47.8	46	121.4	81.1	06	171.3	114.4
27	22.4	15.0	87	72.3	48.3	47	122.2	81.7	07	172.1	115.0
28	23.3	15.6	88	73.2	48.9	48	123.1	82.2	08	172.9	115.5
29	24.1	16.1	89	74.0	49.4	49	123.9	82.8	09	173.8	116.1
30	24.9	16.7	90	74.8	50.0	50	124.7	83.3	10	174.6	116.7
31	25.8	17.2	91	75.7	50.6	151	125.6	83.9	211	175.4	117.2
32	26.6	17.8	92	76.5	51.1	52	126.4	84.4	12	176.3	117.8
33	27.4	18.3	93	77.3	51.7	53	127.2	85.0	13	177.1	118.3
34	28.3	18.9	94	78.2	52.2	54	128.0	85.5	14	177.9	118.9
35	29.1	19.4	95	79.0	52.8	55	128.9	86.1	15	178.8	119.4
36	29.9	20.0	96	79.8	53.3	56	129.7	86.7	16	179.6	120.0
37	30.8	20.6	97	80.7	53.9	57	130.5	87.2	17	180.4	120.5
38	31.6	21.1	98	81.5	54.4	58	131.4	87.8	18	181.3	121.1
39	32.4	21.7	99	82.3	55.0	59	132.2	88.3	19	182.1	121.7
40	33.3	22.2	100	83.1	55.6	60	133.0	88.9	20	182.9	122.2
41	34.1	22.8	101	84.0	56.1	161	133.9	89.4	221	183.8	122.8
42	34.9	23.3	02	84.8	56.7	62	134.7	90.0	22	184.6	123.3
43	35.8	23.9	03	85.6	57.2	63	135.5	90.5	23	185.4	123.9
44	36.6	24.4	04	86.5	57.8	64	136.4	91.1	24	186.2	124.4
45	37.4	25.0	05	87.3	58.3	65	137.2	91.7	25	187.1	125.0
46	38.2	25.6	06	88.1	58.9	66	138.0	92.2	26	187.9	125.5
47	39.1	26.1	07	89.0	59.4	67	138.9	92.8	27	188.7	126.1
48	39.9	26.7	08	89.8	60.0	68	139.7	93.3	28	189.6	126.7
49	40.7	27.2	09	90.6	60.6	69	140.5	93.9	29	190.4	127.2
50	41.6	27.8	10	91.5	61.1	70	141.3	94.4	30	191.2	127.8
51	42.4	28.3	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
52	43.2	28.9	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
53	44.1	29.4	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
54	44.9	30.0	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
55	45.7	30.5	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
56	46.6	31.1	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
57	47.4	31.7	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
58	48.2	32.2	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
59	49.1	32.8	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
60	49.9	33.3	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
61	50.7	33.9	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
62	51.6	34.4	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
63	52.4	35.0	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
64	53.2	35.6	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
65	54.0	36.1	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
66	54.9	36.7	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
67	55.7	37.2	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
68	56.5	37.8	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
69	57.4	38.3	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
70	58.2	38.9	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
71	59.0	39.4	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
72	59.9	40.0	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
73	60.7	40.6	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
74	61.5	41.1	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
75	62.4	41.7	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
76	63.2	42.2	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
77	64.0	42.8	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
78	64.9	43.3	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
79	65.7	43.9	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
80	66.5	44.4	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
81	67.3	45.0	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
82	68.2	45.6	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
83	69.0	46.1	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
84	69.8	46.7	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
85	70.7	47.2	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
86	71.5	47.8	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
87	72.3	48.3	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
88	73.2	48.9	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
89	74.0	49.4	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
90	74.8	50.0	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
91	75.7	50.6	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
92	76.5	51.1	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
93	77.3	51.7	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
94	78.2	52.2	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
95	79.0	52.8	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
96	79.8	53.3	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
97	80.7	53.9	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
98	81.5	54.4	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
99	82.3	55.0	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
100	83.1	55.6	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
101	84.0	56.1	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3
102	84.8	56.7	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9
103	85.6	57.2	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4
104	86.5	57.8	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0
105	87.3	58.3	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5
106	88.1	58.9	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1
107	89.0	59.4	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7
108	89.8	60.0	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2
109	90.6	60.6	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8
110	91.5	61.1	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3
111	92.3	61.7	111	92.3	61.7	171	142.2	95.0	231	192.1	128.

TABLE I.

Difference of Latitude and Departure for $3\frac{1}{2}$ Points.

N.E. 1/4 N.			N.W. 1/4 N.			S.E. 1/4 S.			S.W. 1/4 S.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 8	00 6	61	49 0	36.3	121	97 2	72 1	181	115 4	107.6	241	193 6	143.6
2	01 6	01.2	62	49 8	36 9	22	98 0	72 7	82	146 2	108 4	42	194 4	144.2
3	02 4	01 8	63	50 6	37.5	23	98 8	73.3	83	147.0	109.0	43	195.2	144.8
4	03 2	02 4	64	51 4	38 1	24	99 6	73.9	84	147.8	109 6	44	196 0	145 4
5	04.0	03 0	65	52 2	38 7	25	100.4	74.5	85	148 6	110.2	45	196 8	145.9
6	04.8	03 6	66	53.0	39.3	26	101 2	75 1	86	149 4	110 8	46	197 6	146.5
7	05.6	04 2	67	53 8	39 9	27	102.0	75 7	87	150 2	111 4	47	198 4	147.1
8	06 4	04 8	68	54 6	40 5	28	102 8	76.2	88	151 0	112 0	48	199 2	147.7
9	07 2	05.4	69	55.4	41 1	29	103.6	76.8	89	151.8	112.6	49	200 0	148.3
10	08 0	06.0	70	56 2	41 7	30	104 4	77.4	90	152.6	113.2	50	200 8	148 9
11	08.8	06 6	71	57 0	42 3	131	105 2	78 0	191	153 4	113 8	251	201 6	149.5
12	09 6	07 1	72	57 8	42.9	32	106 0	78 6	92	154 2	114 4	52	202 4	150.1
13	10.4	07.7	73	58 6	43.5	33	106 8	79.2	93	155 0	115 0	53	203.2	150 7
14	11 2	08.3	74	59.4	44 1	34	107.6	79 8	94	155 8	115.6	54	204 0	151.3
15	12.0	08.9	75	60 2	44.7	35	108 4	80.4	95	156 6	116.2	55	204 8	151 9
16	12.9	09.6	76	61.0	45.3	36	109.2	81 0	96	157.4	116 8	56	205 6	152.6
17	13.7	10.1	77	61 8	45.9	37	110.0	81 6	97	158 2	117.4	57	206 4	153.1
18	14.5	10.7	78	62.7	46.5	38	110.8	82 2	98	159 0	117 9	58	207.2	153.7
19	15 3	11.3	79	63.5	47 1	39	111 6	82 8	99	159.8	118 5	59	208 0	154.3
20	16.1	11 9	80	64 3	47 7	40	112 4	83 4	200	160 6	119 1	60	208 8	154.9
21	16 9	12.5	81	65 1	48 3	141	113 3	84.0	201	161 4	119 7	261	209 6	155.5
22	17 7	13 1	82	65 9	48 9	42	114 1	84 6	02	162 2	120 3	62	210 4	156.1
23	18 5	13 7	83	66.7	49.4	43	114 9	85.2	03	163 0	120 9	63	211.2	156.7
24	19 3	14 3	84	67.5	50 0	44	115 7	85 8	04	163 8	121 5	64	212 0	157.3
25	20 1	14 9	85	68 3	50 6	45	116 5	86 4	05	164 6	122 1	65	212 8	157.9
26	20.9	15 5	86	69.1	51.2	46	117 3	87.0	06	165 4	122 7	66	213.7	158.5
27	21 7	16 1	87	69.9	51 8	47	118 1	87 6	07	166 2	123 3	67	214 5	159.1
28	22 5	16 7	88	70 7	52 4	48	118 9	88 2	08	167 0	123 9	68	215 3	159.6
29	23 3	17.3	89	71 5	53 0	49	119 7	88 8	09	167 8	124 5	69	216.1	160 2
30	24.1	17 9	90	72 3	53 6	50	120 5	89 4	10	168 6	125.1	70	216 9	160 8
31	24 9	18 5	91	73 1	54 2	151	121 3	90 0	111	169 4	125.7	271	217 7	161 4
32	25 7	19.1	92	73 9	54 8	52	122 1	90.5	12	170 2	126 3	72	218 5	162 0
33	26.5	19.7	93	74.7	55 4	53	122 9	91 1	13	171 0	126 9	73	219.3	162.6
34	27.3	20.3	94	75.5	56 0	54	123 7	91.7	14	171 8	127 5	74	220 1	163.2
35	28.1	20.9	95	76 3	56.6	55	124 5	92 3	15	172 6	128.1	75	220 9	163.8
36	28 9	21.4	96	77.1	57 2	56	125.3	92.9	16	173 4	128 7	76	221 7	164.4
37	29 7	22.0	97	77 9	57.8	57	126.1	93.5	17	174 2	129 3	77	222 5	165.0
38	30.5	22 6	98	78.7	58 4	58	126.9	94 1	18	175 0	129 9	78	223.3	165.6
39	31.3	23 2	99	79.5	59.0	59	127 7	94 7	19	175 8	130.5	79	224 1	166 2
40	32 1	23 8	100	80 3	59 6	60	128 5	95.3	20	176 6	131.1	80	224 9	166 8
41	32.9	24.4	101	81.1	60 2	161	129 3	95 9	121	177 4	131 6	281	225 7	167 4
42	33 7	25.0	02	81.9	60 8	62	130 1	96 5	22	178 2	132 2	82	226 5	168.0
43	34 5	25.6	03	82.7	61.4	63	130 9	97 1	23	179.1	132 8	83	227 3	168 6
44	35 3	26.2	04	83 5	62 0	64	131 7	97 7	24	179 9	133.4	84	228.1	169 2
45	36 1	26.8	05	84.3	62 6	65	132 5	98 3	25	180 7	134 0	85	229 9	169 8
46	36.9	27.4	06	85 1	63 1	66	133 3	98 9	26	181 5	134 6	86	229.7	170.4
47	37 8	28.0	07	85 9	63.7	67	134 1	99 5	27	182 3	135.2	87	230.5	171 0
48	38 6	28 6	08	86 7	64 3	68	134.9	100.1	28	183 1	135.8	88	231 3	171.6
49	39 4	29.2	09	87.5	64.9	69	135 7	100 7	29	183 9	136 4	89	232 1	172.2
50	40 2	29.8	110	88 4	65.5	70	136 5	101 3	30	184 7	137 0	90	232.9	172 8
51	41 0	30.4	111	89 2	66 1	171	137 3	101 9	231	185 5	137 6	291	233.7	173 3
52	41.8	31.0	12	90.0	66.7	72	138 2	102.5	32	186 3	138 2	92	234 5	173.9
53	42.6	31.6	13	90.8	67.3	73	139 0	103 1	33	187 1	138 8	93	235 3	174.5
54	43.4	32.2	14	91.6	67 9	74	139 8	103 7	34	188 0	139.4	94	236 1	175.1
55	44 2	32 8	15	92 4	68.5	75	140 6	104.2	35	188 8	140 0	95	236 9	175.7
56	45.0	33 4	16	93.2	69 1	76	141 4	104.8	36	189 6	140 6	96	237 7	176.3
57	45.8	34.0	17	94.0	69 7	77	142 2	105 4	37	190 4	141 2	97	238 5	176.9
58	46.6	34.6	18	94.8	70.3	78	143 0	106 0	38	191 2	141 8	98	239 3	177.5
59	47 4	35.1	19	95 6	70.9	79	143.8	106.6	39	192 0	142 4	99	240 1	178 1
60	48 2	35.7	20	96 4	71 5	80	144 6	107 2	40	192 8	143 0	200	241 0	178.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E. 1/4 N.			S.E. 1/4 S.			N.W. 1/4 N.			S.W. 1/4 S.			[For 4 1/2 Points]		

TABLE 1.

Difference of Latitude and Departure for 34 Points.

N.E. 1/4 N.			N.W. 1/4 N.			S.E. 1/4 S.			S.W. 1/4 S.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.2	38.7	121	93.5	76.8	181	139.9	114.5
2	01.5	01.3	62	47.9	39.3	22	94.3	77.4	82	140.7	115.5
3	02.3	01.9	63	48.7	40.0	23	95.1	78.0	83	141.5	116.1
4	03.1	02.5	64	49.5	40.6	24	95.9	78.7	84	142.2	116.7
5	03.9	03.2	65	50.2	41.2	25	96.6	79.3	85	143.0	117.4
6	04.6	03.8	66	51.0	41.9	26	97.4	79.9	86	143.8	118.0
7	05.4	04.4	67	51.8	42.5	27	98.2	80.6	87	144.6	118.5
8	06.2	05.1	68	52.6	43.1	28	99.0	81.2	88	145.3	119.3
9	07.0	05.7	69	53.3	43.8	29	99.7	81.8	89	146.1	119.9
10	07.7	06.3	70	54.1	44.4	30	100.5	82.5	90	146.9	120.5
11	08.5	07.0	71	54.9	45.0	31	101.3	83.1	191	147.6	121.2
12	09.3	07.6	72	55.7	45.7	32	102.0	83.7	92	148.4	121.8
13	10.0	08.2	73	56.4	46.3	33	102.8	84.4	93	149.2	122.4
14	10.8	08.9	74	57.2	46.9	34	103.6	85.0	94	150.0	123.1
15	11.6	09.5	75	58.0	47.6	35	104.4	85.6	95	150.7	123.7
16	12.4	10.2	76	58.7	48.2	36	105.1	86.3	96	151.5	124.3
17	13.1	10.8	77	59.5	48.8	37	105.9	86.9	97	152.3	125.0
18	13.9	11.4	78	60.3	49.5	38	106.7	87.5	98	153.1	125.6
19	14.7	12.1	79	61.1	50.1	39	107.4	88.2	99	153.8	126.2
20	15.5	12.7	80	61.8	50.8	40	108.2	88.8	200	154.6	126.9
21	16.2	13.3	81	62.6	51.4	41	109.0	89.4	201	155.4	127.5
22	17.0	14.0	82	63.4	52.0	42	109.8	90.1	02	156.1	128.1
23	17.8	14.6	83	64.2	52.7	43	110.5	90.7	03	156.9	128.8
24	18.6	15.2	84	64.9	53.3	44	111.3	91.4	04	157.7	129.4
25	19.3	15.9	85	65.7	53.9	45	112.1	92.0	05	158.5	130.1
26	20.1	16.5	86	66.5	54.6	46	112.9	92.6	06	159.2	130.7
27	20.9	17.1	87	67.3	55.2	47	113.6	93.3	07	160.0	131.3
28	21.6	17.8	88	68.0	55.8	48	114.4	93.9	08	160.8	132.0
29	22.4	18.4	89	68.8	56.5	49	115.2	94.5	09	161.6	132.6
30	23.2	19.1	90	69.6	57.1	50	116.0	95.2	10	162.3	133.2
31	24.0	19.7	91	70.3	57.7	51	116.7	95.8	211	163.1	133.9
32	24.7	20.3	92	71.1	58.4	52	117.5	96.4	12	163.9	134.5
33	25.5	20.9	93	71.9	59.0	53	118.3	97.1	13	164.7	135.1
34	26.3	21.6	94	72.7	59.6	54	119.0	97.7	14	165.4	135.8
35	27.1	22.2	95	73.4	60.3	55	119.8	98.3	15	166.2	136.4
36	27.8	22.8	96	74.2	60.9	56	120.6	99.0	16	167.0	137.0
37	28.6	23.4	97	75.0	61.5	57	121.4	99.6	17	167.7	137.7
38	29.4	24.1	98	75.8	62.2	58	122.1	100.2	18	168.5	138.3
39	30.1	24.7	99	76.5	62.8	59	122.9	100.9	19	169.3	138.9
40	30.9	25.4	100	77.3	63.4	60	123.7	101.5	20	170.1	139.6
41	31.7	26.0	101	78.1	64.1	61	124.5	102.1	221	170.8	140.2
42	32.5	26.6	02	78.8	64.7	62	125.2	102.8	22	171.6	140.8
43	33.3	27.3	03	79.6	65.3	63	126.0	103.4	23	172.4	141.5
44	34.0	27.9	04	80.4	66.0	64	126.8	104.0	24	173.2	142.1
45	34.8	28.5	05	81.2	66.6	65	127.5	104.7	25	173.9	142.7
46	35.6	29.2	06	81.9	67.2	66	128.3	105.3	26	174.7	143.4
47	36.3	29.8	07	82.7	67.9	67	129.1	105.9	27	175.5	144.0
48	37.1	30.5	08	83.5	68.5	68	129.9	106.6	28	176.2	144.6
49	37.9	31.1	09	84.3	69.1	69	130.6	107.2	29	177.0	145.3
50	38.7	31.7	10	85.1	69.7	70	131.4	107.8	30	177.8	145.9
51	39.4	32.4	11	85.8	70.4	71	132.2	108.5	231	178.6	146.5
52	40.2	33.0	12	86.6	71.1	72	133.0	109.1	32	179.3	147.2
53	41.0	33.6	13	87.4	71.7	73	133.7	109.8	33	180.1	147.8
54	41.7	34.3	14	88.1	72.3	74	134.5	110.4	34	180.9	148.4
55	42.5	34.9	15	88.9	73.0	75	135.3	111.0	35	181.7	149.1
56	43.3	35.5	16	89.7	73.6	76	136.0	111.7	36	182.4	149.7
57	44.1	36.2	17	90.4	74.2	77	136.8	112.3	37	183.2	150.4
58	44.8	36.8	18	91.2	74.9	78	137.6	112.9	38	184.0	151.0
59	45.6	37.4	19	92.0	75.5	79	138.4	113.6	39	184.7	151.6
60	46.4	38.1	20	92.8	76.1	80	139.1	114.2	40	185.5	152.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E. 1/4 E.			S.E. 1/4 E.			N.W. 1/4 W.			S.W. 1/4 W.		
									For 4 Points		

TABLE I.

Difference of Latitude and Departure for 4 Points.

N.E.			N.W.			S.E.			S.W.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	211	156.3	156.3
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7
61	43.1	43.1	21	85.6	85.6	181	128.0	128.0	241	170.4	170.4
62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
71	50.2	50.2	31	92.6	92.6	191	135.1	135.1	251	177.5	177.5
72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
81	57.3	57.3	41	99.7	99.7	201	142.1	142.1	261	184.6	184.6
82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
91	64.3	64.3	51	106.8	106.8	11	149.2	149.2	271	191.6	191.6
92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.4	194.4
96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
101	71.4	71.4	61	113.8	113.8	21	156.3	156.3	281	198.7	198.7
102	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
103	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
104	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
105	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
106	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
107	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
108	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
109	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.3	204.3
110	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.0	205.0

TABLE II.

17

Difference of Latitude and Departure for 1 Degree.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	01.1	121	121.0	02.1	181	181.0	03.2	241	241.0	04.3
2	02.0	00.0	62	62.0	01.1	122	122.0	02.1	182	182.0	03.2	242	242.0	04.3
3	03.0	00.1	63	63.0	01.1	123	123.0	02.1	183	183.0	03.2	243	243.0	04.3
4	04.0	00.1	64	64.0	01.1	124	124.0	02.2	184	184.0	03.2	244	244.0	04.3
5	05.0	00.1	65	65.0	01.1	125	125.0	02.2	185	185.0	03.2	245	245.0	04.3
6	06.0	00.1	66	66.0	01.2	126	126.0	02.2	186	186.0	03.2	246	246.0	04.3
7	07.0	00.1	67	67.0	01.2	127	127.0	02.2	187	187.0	03.3	247	247.0	04.3
8	08.0	00.1	68	68.0	01.2	128	128.0	02.2	188	188.0	03.3	248	248.0	04.3
9	09.0	00.2	69	69.0	01.2	129	129.0	02.3	189	189.0	03.3	249	249.0	04.3
10	10.0	00.2	70	70.0	01.2	130	130.0	02.3	190	190.0	03.3	250	250.0	04.4
11	11.0	00.2	71	71.0	01.2	131	131.0	02.3	191	191.0	03.3	251	251.0	04.4
12	12.0	00.2	72	72.0	01.3	132	132.0	02.3	192	192.0	03.4	252	252.0	04.4
13	13.0	00.2	73	73.0	01.3	133	133.0	02.3	193	193.0	03.4	253	253.0	04.4
14	14.0	00.2	74	74.0	01.3	134	134.0	02.3	194	194.0	03.4	254	254.0	04.4
15	15.0	00.3	75	75.0	01.3	135	135.0	02.4	195	195.0	03.4	255	255.0	04.5
16	16.0	00.3	76	76.0	01.3	136	136.0	02.4	196	196.0	03.4	256	256.0	04.5
17	17.0	00.3	77	77.0	01.3	137	137.0	02.4	197	197.0	03.4	257	257.0	04.5
18	18.0	00.3	78	78.0	01.4	138	138.0	02.4	198	198.0	03.5	258	258.0	04.5
19	19.0	00.3	79	79.0	01.4	139	139.0	02.4	199	199.0	03.5	259	259.0	04.5
20	20.0	00.3	80	80.0	01.4	140	140.0	02.4	200	200.0	03.5	260	260.0	04.5
21	21.0	00.4	81	81.0	01.4	141	141.0	02.5	201	201.0	03.5	261	261.0	04.6
22	22.0	00.4	82	82.0	01.4	142	142.0	02.5	202	202.0	03.5	262	262.0	04.6
23	23.0	00.4	83	83.0	01.4	143	143.0	02.5	203	203.0	03.5	263	263.0	04.6
24	24.0	00.4	84	84.0	01.5	144	144.0	02.5	204	204.0	03.6	264	264.0	04.6
25	25.0	00.4	85	85.0	01.5	145	145.0	02.5	205	205.0	03.6	265	265.0	04.6
26	26.0	00.5	86	86.0	01.5	146	146.0	02.5	206	206.0	03.6	266	266.0	04.6
27	27.0	00.5	87	87.0	01.5	147	147.0	02.6	207	207.0	03.6	267	267.0	04.7
28	28.0	00.5	88	88.0	01.5	148	148.0	02.6	208	208.0	03.6	268	268.0	04.7
29	29.0	00.5	89	89.0	01.6	149	149.0	02.6	209	209.0	03.6	269	269.0	04.7
30	30.0	00.5	90	90.0	01.6	150	150.0	02.6	210	210.0	03.7	270	270.0	04.7
31	31.0	00.6	91	91.0	01.6	151	151.0	02.6	211	211.0	03.7	271	271.0	04.7
32	32.0	00.6	92	92.0	01.6	152	152.0	02.7	212	212.0	03.7	272	272.0	04.7
33	33.0	00.6	93	93.0	01.6	153	153.0	02.7	213	213.0	03.7	273	273.0	04.8
34	34.0	00.6	94	94.0	01.6	154	154.0	02.7	214	214.0	03.7	274	274.0	04.8
35	35.0	00.6	95	95.0	01.7	155	155.0	02.7	215	215.0	03.8	275	275.0	04.8
36	36.0	00.6	96	96.0	01.7	156	156.0	02.7	216	216.0	03.8	276	276.0	04.8
37	37.0	00.6	97	97.0	01.7	157	157.0	02.7	217	217.0	03.8	277	277.0	04.8
38	38.0	00.7	98	98.0	01.7	158	158.0	02.8	218	218.0	03.8	278	278.0	04.9
39	39.0	00.7	99	99.0	01.7	159	159.0	02.8	219	219.0	03.8	279	279.0	04.9
40	40.0	00.7	100	100.0	01.7	160	160.0	02.8	220	220.0	03.8	280	280.0	04.9
41	41.0	00.7	101	101.0	01.8	161	161.0	02.8	221	221.0	03.9	281	281.0	04.9
42	42.0	00.7	102	102.0	01.8	162	162.0	02.8	222	222.0	03.9	282	282.0	04.9
43	43.0	00.8	103	103.0	01.8	163	163.0	02.8	223	223.0	03.9	283	283.0	04.9
44	44.0	00.8	104	104.0	01.8	164	164.0	02.9	224	224.0	03.9	284	284.0	05.0
45	45.0	00.8	105	105.0	01.8	165	165.0	02.9	225	225.0	03.9	285	285.0	05.0
46	46.0	00.8	106	106.0	01.8	166	166.0	02.9	226	226.0	03.9	286	286.0	05.0
47	47.0	00.8	107	107.0	01.9	167	167.0	02.9	227	227.0	04.0	287	287.0	05.0
48	48.0	00.8	108	108.0	01.9	168	168.0	02.9	228	228.0	04.0	288	288.0	05.0
49	49.0	00.9	109	109.0	01.9	169	169.0	02.9	229	229.0	04.0	289	289.0	05.0
50	50.0	00.9	110	110.0	01.9	170	170.0	03.0	230	230.0	04.0	290	290.0	05.1
51	51.0	00.9	111	111.0	01.9	171	171.0	03.0	231	231.0	04.0	291	291.0	05.1
52	52.0	00.9	112	112.0	02.0	172	172.0	03.0	232	232.0	04.0	292	292.0	05.1
53	53.0	00.9	113	113.0	02.0	173	173.0	03.0	233	233.0	04.1	293	293.0	05.1
54	54.0	00.9	114	114.0	02.0	174	174.0	03.0	234	234.0	04.1	294	294.0	05.1
55	55.0	01.0	115	115.0	02.0	175	175.0	03.1	235	235.0	04.1	295	295.0	05.1
56	56.0	01.0	116	116.0	02.0	176	176.0	03.1	236	236.0	04.1	296	296.0	05.2
57	57.0	01.0	117	117.0	02.1	177	177.0	03.1	237	237.0	04.1	297	297.0	05.2
58	58.0	01.0	118	118.0	02.1	178	178.0	03.1	238	238.0	04.2	298	298.0	05.2
59	59.0	01.0	119	119.0	02.1	179	179.0	03.1	239	239.0	04.2	299	299.0	05.2
60	60.0	01.0	120	120.0	02.1	180	180.0	03.1	240	240.0	04.2	300	300.0	05.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 89 Degrees.]

TABLE II.

Difference of Latitude and Departure for 2 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	02.1	121	120.9	04.2	181	180.9	06.3	241	240.9	08.4
2	02.0	00.1	62	62.0	02.2	22	121.9	04.3	82	181.9	06.4	42	241.9	08.4
3	03.0	00.1	63	63.0	02.2	23	122.9	04.3	83	182.9	06.4	43	242.9	08.5
4	04.0	00.1	64	64.0	02.2	24	123.9	04.3	84	183.9	06.4	44	243.9	08.5
5	05.0	00.2	65	65.0	02.3	25	124.9	04.4	85	184.9	06.5	45	244.9	08.6
6	06.0	00.2	66	66.0	02.3	26	125.9	04.4	86	185.9	06.5	46	245.9	08.6
7	07.0	00.2	67	67.0	02.3	27	126.9	04.4	87	186.9	06.5	47	246.8	08.6
8	08.0	00.3	68	68.0	02.4	28	127.9	04.5	88	187.9	06.6	48	247.8	08.7
9	09.0	00.3	69	69.0	02.4	29	128.9	04.5	89	188.9	06.6	49	248.8	08.7
10	10.0	00.3	70	70.0	02.4	30	129.9	04.5	90	189.9	06.6	50	249.8	08.7
11	11.0	00.4	71	71.0	02.5	131	130.9	04.6	191	190.9	06.7	251	250.8	08.8
12	12.0	00.4	72	72.0	02.5	32	131.9	04.6	92	191.9	06.7	52	251.8	08.8
13	13.0	00.5	73	73.0	02.5	33	132.9	04.6	93	192.9	06.7	53	252.8	08.8
14	14.0	00.5	74	74.0	02.6	34	133.9	04.7	94	193.9	06.8	54	253.8	08.9
15	15.0	00.5	75	75.0	02.6	35	134.9	04.7	95	194.9	06.8	55	254.8	08.9
16	16.0	00.6	76	76.0	02.7	36	135.9	04.7	96	195.9	06.8	56	255.8	08.9
17	17.0	00.6	77	77.0	02.7	37	136.9	04.8	97	196.9	06.9	57	256.8	09.0
18	18.0	00.6	78	78.0	02.7	38	137.9	04.8	98	197.9	06.9	58	257.8	09.0
19	19.0	00.7	79	79.0	02.8	39	138.9	04.9	99	198.9	06.9	59	258.8	09.0
20	20.0	00.7	80	80.0	02.8	40	139.9	04.9	200	199.9	07.0	60	259.8	09.1
21	21.0	00.7	81	81.0	02.8	141	140.9	04.9	201	200.9	07.0	261	260.8	09.1
22	22.0	00.8	82	82.0	02.9	42	141.9	05.0	02	201.9	07.0	62	261.8	09.1
23	23.0	00.8	83	82.9	02.9	43	142.9	05.0	03	202.9	07.1	63	262.8	09.2
24	24.0	00.8	84	83.9	02.9	44	143.9	05.0	04	203.9	07.1	64	263.8	09.2
25	25.0	00.9	85	84.9	03.0	45	144.9	05.1	05	204.9	07.2	65	264.8	09.2
26	26.0	00.9	86	85.9	03.0	46	145.9	05.1	06	205.9	07.2	66	265.8	09.3
27	27.0	00.9	87	86.9	03.0	47	146.9	05.1	07	206.9	07.2	67	266.8	09.3
28	28.0	01.0	88	87.9	03.1	48	147.9	05.2	08	207.9	07.3	68	267.8	09.4
29	29.0	01.0	89	88.9	03.1	49	148.9	05.2	09	208.9	07.3	69	268.8	09.4
30	30.0	01.0	90	89.9	03.1	50	149.9	05.2	10	209.9	07.3	70	269.8	09.4
31	31.0	01.1	91	90.9	03.2	151	150.9	05.3	211	210.9	07.4	271	270.8	09.5
32	32.0	01.1	92	91.9	03.2	52	151.9	05.3	12	211.9	07.4	72	271.8	09.5
33	33.0	01.2	93	92.9	03.2	53	152.9	05.3	13	212.9	07.4	73	272.8	09.5
34	34.0	01.2	94	93.9	03.3	54	153.9	05.4	14	213.9	07.5	74	273.8	09.6
35	35.0	01.2	95	94.9	03.3	55	154.9	05.4	15	214.9	07.5	75	274.8	09.6
36	36.0	01.3	96	95.9	03.4	56	155.9	05.4	16	215.9	07.5	76	275.8	09.6
37	37.0	01.3	97	96.9	03.4	57	156.9	05.5	17	216.9	07.6	77	276.8	09.7
38	38.0	01.3	98	97.9	03.4	58	157.9	05.5	18	217.9	07.6	78	277.8	09.7
39	39.0	01.4	99	98.9	03.5	59	158.9	05.5	19	218.9	07.6	79	278.8	09.7
40	40.0	01.4	100	99.9	03.5	60	159.9	05.6	20	219.9	07.7	80	279.8	09.8
41	41.0	01.4	101	100.9	03.5	161	160.9	05.6	221	220.9	07.7	281	280.8	09.8
42	42.0	01.5	02	101.9	03.6	62	161.9	05.7	22	221.9	07.7	82	281.8	09.8
43	43.0	01.5	03	102.9	03.6	63	162.9	05.7	23	222.9	07.8	83	282.8	09.9
44	44.0	01.5	04	103.9	03.6	64	163.9	05.7	24	223.9	07.8	84	283.8	09.9
45	45.0	01.6	05	104.9	03.7	65	164.9	05.8	25	224.9	07.9	85	284.8	09.9
46	46.0	01.6	06	105.9	03.7	66	165.9	05.8	26	225.9	07.9	86	285.8	10.0
47	47.0	01.6	07	106.9	03.7	67	166.9	05.8	27	226.9	07.9	87	286.8	10.0
48	48.0	01.7	08	107.9	03.8	68	167.9	05.9	28	227.9	08.0	88	287.8	10.1
49	49.0	01.7	09	108.9	03.8	69	168.9	05.9	29	228.9	08.0	89	288.8	10.1
50	50.0	01.7	10	109.9	03.8	70	169.9	05.9	30	229.9	08.0	90	289.8	10.1
51	51.0	01.8	111	110.9	03.9	171	170.9	06.0	231	230.9	08.1	291	290.8	10.2
52	52.0	01.8	12	111.9	03.9	72	171.9	06.0	32	231.9	08.1	92	291.8	10.2
53	53.0	01.8	13	112.9	03.9	73	172.9	06.0	33	232.9	08.1	93	292.8	10.2
54	54.0	01.9	14	113.9	04.0	74	173.9	06.1	34	233.9	08.2	94	293.8	10.3
55	55.0	01.9	15	114.9	04.0	75	174.9	06.1	35	234.9	08.2	95	294.8	10.3
56	56.0	02.0	16	115.9	04.0	76	175.9	06.1	36	235.9	08.2	96	295.8	10.3
57	57.0	02.0	17	116.9	04.1	77	176.9	06.2	37	236.9	08.3	97	296.8	10.4
58	58.0	02.0	18	117.9	04.1	78	177.9	06.2	38	237.9	08.3	98	297.8	10.4
59	59.0	02.1	19	118.9	04.2	79	178.9	06.2	39	238.9	08.3	99	298.8	10.4
60	60.0	02.1	20	119.9	04.2	80	179.9	06.3	40	239.9	08.4	300	299.8	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 88 Degrees.]

TABLE II.

Difference of Latitude and Departure for 3 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00.1	61	60 9	03 2	121	120 8	06 3	181	180 8	09 3	241	240 7	12 3
2	02 0	00.1	62	61 9	03 2	122	121 8	06 4	182	181 8	09 4	242	241 7	12 7
3	03 0	00.2	63	62 9	03 3	123	122 8	06 4	183	182 7	09 6	243	242 7	12 7
4	04 0	00.2	64	63 9	03 3	124	123 8	06 5	184	183 7	09 7	244	243 7	12 8
5	05 0	00 3	65	64 9	03 4	125	124 8	06 5	185	184 7	09 7	245	244 7	12 8
6	06 0	00 3	66	65 9	03 5	126	125 8	06 6	186	185 7	09 7	246	245 7	12 9
7	07 0	00 4	67	66 9	03 5	127	126 8	06 6	187	186 7	09 8	247	246 7	12 9
8	08 0	00 4	68	67 9	03 6	128	127 3	06 7	188	187 7	09 8	248	247 7	13 0
9	09 0	00 5	69	68 9	03 6	129	128 3	06 8	189	188 7	09 9	249	248 7	13 0
10	10 0	00 5	70	69 9	03 7	130	129 3	06 8	190	189 7	09 9	250	249 7	13 1
11	11 0	00 6	71	70 9	03 7	131	130 8	06 9	191	190 7	10 0	251	250 7	13 1
12	12 0	00 6	72	71 9	03 8	132	131 8	06 9	192	191 7	10 0	252	251 7	13 2
13	13 0	00 7	73	72 9	03 8	133	132 8	07 0	193	192 7	10 1	253	252 7	13 2
14	14 0	00 7	74	73 9	03 9	134	133 8	07 0	194	193 7	10 2	254	253 7	13 3
15	15 0	00 8	75	74 9	03 9	135	134 8	07 1	195	194 7	10 2	255	254 7	13 3
16	16 0	00 8	76	75 9	04 0	136	135 8	07 1	196	195 7	10 3	256	255 6	13 4
17	17 0	00 9	77	76 9	04 0	137	136 8	07 2	197	196 7	10 3	257	256 6	13 5
18	18 0	00 9	78	77 9	04 1	138	137 8	07 2	198	197 7	10 4	258	257 6	13 5
19	19 0	01 0	79	78 9	04 1	139	138 8	07 3	199	198 7	10 4	259	258 6	13 6
20	20 0	01 0	80	79 9	04 2	140	139 8	07 3	200	199 7	10 5	260	259 6	13 6
21	21 0	01 1	81	80 9	04 2	141	140 8	07 4	201	200 7	10 5	261	260 6	13 7
22	22 0	01 2	82	81 9	04 3	142	141 8	07 4	202	201 7	10 6	262	261 6	13 7
23	23 0	01 2	83	82 9	04 3	143	142 8	07 5	203	202 7	10 6	263	262 6	13 8
24	24 0	01 3	84	83 9	04 4	144	143 8	07 5	204	203 7	10 7	264	263 6	13 8
25	25 0	01 3	85	84 9	04 4	145	144 8	07 6	205	204 7	10 7	265	264 6	13 9
26	26 0	01 4	86	85 9	04 5	146	145 8	07 6	206	205 7	10 8	266	265 6	13 9
27	27 0	01 4	87	86 9	04 6	147	146 8	07 7	207	206 7	10 8	267	266 6	14 0
28	28 0	01 5	88	87 9	04 6	148	147 8	07 7	208	207 7	10 9	268	267 6	14 0
29	29 0	01 5	89	88 9	04 7	149	148 8	07 8	209	208 7	10 9	269	268 6	14 1
30	30 0	01 6	90	89 9	04 7	150	149 8	07 9	210	209 7	11 0	270	269 6	14 1
31	31 0	01 6	91	90 9	04 8	151	150 8	07 9	211	210 7	11 0	271	270 6	14 2
32	32 0	01 7	92	91 9	04 8	152	151 8	08 0	212	211 7	11 1	272	271 6	14 2
33	33 0	01 7	93	92 9	04 9	153	152 8	08 0	213	212 7	11 1	273	272 6	14 3
34	34 0	01 8	94	93 9	04 9	154	153 8	08 1	214	213 7	11 2	274	273 6	14 3
35	35 0	01 8	95	94 9	05 0	155	154 8	08 1	215	214 7	11 2	275	274 6	14 4
36	36 0	01 9	96	95 9	05 0	156	155 8	08 2	216	215 7	11 3	276	275 6	14 4
37	36 9	01 9	97	96 9	05 1	157	156 8	08 2	217	216 7	11 4	277	276 6	14 5
38	37 9	02 0	98	97 9	05 1	158	157 8	08 3	218	217 7	11 4	278	277 6	14 5
39	38 9	02 0	99	98 9	05 2	159	158 8	08 3	219	218 7	11 5	279	278 6	14 6
40	39 9	02 1	100	99 9	05 2	160	159 8	08 4	220	219 7	11 5	280	279 6	14 7
41	40 9	02 1	101	100 9	05 3	161	160 8	08 4	221	220 7	11 6	281	280 6	14 7
42	41 9	02 2	102	101 9	05 3	162	161 8	08 5	222	221 7	11 6	282	281 6	14 8
43	42 9	02 3	103	102 9	05 4	163	162 8	08 5	223	222 7	11 7	283	282 6	14 8
44	43 9	02 3	104	103 9	05 4	164	163 8	08 6	224	223 7	11 7	284	283 6	14 9
45	44 9	02 4	105	104 9	05 5	165	164 8	08 6	225	224 7	11 8	285	284 6	14 9
46	45 9	02 4	106	105 9	05 5	166	165 8	08 7	226	225 7	11 8	286	285 6	15 0
47	46 9	02 5	107	106 9	05 6	167	166 8	08 7	227	226 7	11 9	287	286 6	15 0
48	47 9	02 5	108	107 9	05 7	168	167 8	08 8	228	227 7	11 9	288	287 6	15 1
49	48 9	02 6	109	108 9	05 7	169	168 8	08 8	229	228 7	12 0	289	288 6	15 1
50	49 9	02 6	110	109 9	05 8	170	169 8	08 9	230	229 7	12 0	290	289 6	15 2
51	50 9	02 7	111	110 9	05 8	171	170 8	08 9	231	230 7	12 1	291	290 6	15 2
52	51 9	02 7	112	111 9	05 9	172	171 8	09 0	232	231 7	12 1	292	291 6	15 3
53	52 9	02 8	113	112 9	05 9	173	172 8	09 1	233	232 7	12 2	293	292 6	15 3
54	53 9	02 8	114	113 9	06 0	174	173 8	09 1	234	233 7	12 2	294	293 6	15 4
55	54 9	02 9	115	114 9	06 0	175	174 8	09 2	235	234 7	12 3	295	294 6	15 4
56	55 9	02 9	116	115 9	06 1	176	175 8	09 2	236	235 7	12 4	296	295 6	15 5
57	56 9	03 0	117	116 9	06 1	177	176 8	09 3	237	236 7	12 4	297	296 6	15 5
58	57 9	03 0	118	117 9	06 2	178	177 8	09 3	238	237 7	12 5	298	297 6	15 6
59	58 9	03 1	119	118 9	06 2	179	178 8	09 4	239	238 7	12 5	299	298 6	15 6
60	59 9	03 1	120	119 9	06 3	180	179 8	09 4	240	239 7	12 6	300	299 6	15 7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 57 Degrees.)

TABLE II.

Difference of Latitude and Departure for 4 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.9
2	02.0	00.1	62	61.8	04.3	122	121.7	08.5	182	181.6	12.7	242	241.4	16.9
3	03.0	00.2	63	62.8	04.4	123	122.7	08.6	183	182.6	12.8	243	242.4	17.0
4	04.0	00.3	64	63.8	04.5	124	123.7	08.6	184	183.6	12.8	244	243.4	17.0
5	05.0	00.3	65	64.8	04.5	125	124.7	08.7	185	184.5	12.9	245	244.4	17.1
6	06.0	00.4	66	65.8	04.6	126	125.7	08.8	186	185.5	13.0	246	245.4	17.2
7	07.0	00.5	67	66.8	04.7	127	126.7	08.9	187	186.5	13.0	247	246.4	17.2
8	08.0	00.6	68	67.8	04.7	128	127.7	08.9	188	187.5	13.1	248	247.4	17.3
9	09.0	00.6	69	68.8	04.8	129	128.7	09.0	189	188.5	13.2	249	248.4	17.4
10	10.0	00.7	70	69.8	04.9	130	129.7	09.1	190	189.5	13.3	250	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	132	131.7	09.2	192	191.5	13.4	252	251.4	17.6
13	13.0	00.9	73	72.8	05.1	133	132.7	09.3	193	192.5	13.5	253	252.4	17.6
14	14.0	01.0	74	73.8	05.2	134	133.7	09.3	194	193.5	13.5	254	253.4	17.7
15	15.0	01.0	75	74.8	05.2	135	134.7	09.4	195	194.5	13.6	255	254.4	17.8
16	16.0	01.1	76	75.8	05.3	136	135.7	09.5	196	195.5	13.7	256	255.4	17.9
17	17.0	01.2	77	76.8	05.4	137	136.7	09.6	197	196.5	13.7	257	256.4	17.9
18	18.0	01.3	78	77.8	05.4	138	137.7	09.6	198	197.5	13.8	258	257.4	18.0
19	19.0	01.3	79	78.8	05.5	139	138.7	09.7	199	198.5	13.9	259	258.4	18.1
20	20.0	01.4	80	79.8	05.6	140	139.7	09.8	200	199.5	14.0	260	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	142	141.7	09.9	202	201.5	14.1	262	261.4	18.3
23	22.9	01.6	83	82.8	05.8	143	142.7	10.0	203	202.5	14.2	263	262.4	18.3
24	23.9	01.7	84	83.8	05.9	144	143.6	10.0	204	203.5	14.2	264	263.4	18.4
25	24.9	01.7	85	84.8	05.9	145	144.6	10.1	205	204.5	14.3	265	264.4	18.5
26	25.9	01.8	86	85.8	06.0	146	145.6	10.2	206	205.5	14.4	266	265.4	18.6
27	26.9	01.9	87	86.8	06.1	147	146.6	10.3	207	206.5	14.4	267	266.4	18.6
28	27.9	02.0	88	87.8	06.1	148	147.6	10.3	208	207.5	14.5	268	267.4	18.7
29	28.9	02.0	89	88.8	06.2	149	148.6	10.4	209	208.5	14.6	269	268.4	18.8
30	29.9	02.1	90	89.8	06.3	150	149.6	10.5	210	209.5	14.6	270	269.4	18.8
31	30.9	02.2	91	90.8	06.3	151	150.6	10.5	211	210.5	14.7	271	270.4	18.9
32	31.9	02.2	92	91.8	06.4	152	151.6	10.6	212	211.5	14.8	272	271.4	19.0
33	32.9	02.3	93	92.8	06.5	153	152.6	10.7	213	212.5	14.9	273	272.4	19.0
34	33.9	02.4	94	93.8	06.6	154	153.6	10.7	214	213.5	14.9	274	273.4	19.1
35	34.9	02.4	95	94.8	06.6	155	154.6	10.8	215	214.5	15.0	275	274.4	19.2
36	35.9	02.5	96	95.8	06.7	156	155.6	10.9	216	215.5	15.1	276	275.4	19.3
37	36.9	02.6	97	96.8	06.8	157	156.6	11.0	217	216.5	15.1	277	276.4	19.3
38	37.9	02.7	98	97.8	06.8	158	157.6	11.0	218	217.5	15.2	278	277.4	19.4
39	38.9	02.7	99	98.8	06.9	159	158.6	11.1	219	218.5	15.3	279	278.4	19.5
40	39.9	02.8	100	99.8	07.0	160	159.6	11.2	220	219.5	15.3	280	279.4	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.4	19.6
42	41.9	02.9	102	101.8	07.1	162	161.6	11.3	222	221.5	15.5	282	281.4	19.7
43	42.9	03.0	103	102.7	07.2	163	162.6	11.4	223	222.5	15.6	283	282.4	19.7
44	43.9	03.1	104	103.7	07.3	164	163.6	11.4	224	223.5	15.6	284	283.4	19.8
45	44.9	03.1	105	104.7	07.3	165	164.6	11.5	225	224.5	15.7	285	284.4	19.9
46	45.9	03.2	106	105.7	07.4	166	165.6	11.6	226	225.5	15.8	286	285.4	20.0
47	46.9	03.3	107	106.7	07.5	167	166.6	11.6	227	226.5	15.8	287	286.4	20.0
48	47.9	03.3	108	107.7	07.5	168	167.6	11.7	228	227.5	15.9	288	287.4	20.1
49	48.9	03.4	109	108.7	07.6	169	168.6	11.8	229	228.5	16.0	289	288.4	20.2
50	49.9	03.5	110	109.7	07.7	170	169.6	11.9	230	229.5	16.0	290	289.4	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.5	16.1	291	290.4	20.3
52	51.9	03.6	112	111.7	07.8	172	171.6	12.0	232	231.5	16.2	292	291.4	20.4
53	52.9	03.7	113	112.7	07.9	173	172.6	12.1	233	232.5	16.3	293	292.4	20.4
54	53.9	03.8	114	113.7	08.0	174	173.6	12.1	234	233.5	16.3	294	293.4	20.5
55	54.9	03.8	115	114.7	08.0	175	174.6	12.2	235	234.5	16.4	295	294.4	20.6
56	55.9	03.9	116	115.7	08.1	176	175.6	12.3	236	235.5	16.5	296	295.4	20.6
57	56.9	04.0	117	116.7	08.2	177	176.6	12.3	237	236.5	16.5	297	296.4	20.7
58	57.9	04.0	118	117.7	08.2	178	177.6	12.4	238	237.5	16.6	298	297.4	20.8
59	58.9	04.1	119	118.7	08.3	179	178.6	12.5	239	238.5	16.7	299	298.4	20.9
60	59.9	04.2	120	119.7	08.4	180	179.6	12.6	240	239.5	16.7	300	299.4	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 66 Degrees.)

TABLE II.

21

Difference of Latitude and Departure for 5 Degrees.

Lat.	Dist.	Lat.	Dist.	Lat.	Dist.	Lat.	Dist.	Lat.	Dist.	Lat.	Dist.	Lat.	Dist.
00.1	61	60.8	05.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0	
00.2	62	61.8	05.4	22	121.5	10.6	82	181.3	15.9	42	241.1	21.1	
00.3	63	62.8	05.5	23	122.5	10.7	83	182.3	15.9	43	242.1	21.2	
00.3	64	63.8	05.6	24	123.5	10.8	84	183.3	16.0	44	243.1	21.3	
00.4	65	64.8	05.7	25	124.5	10.9	85	184.3	16.1	45	244.1	21.4	
00.5	66	65.7	05.7	26	125.5	11.0	86	185.3	16.2	46	245.1	21.4	
00.6	67	66.7	05.8	27	126.5	11.1	87	186.3	16.3	47	246.1	21.5	
00.7	68	67.7	05.9	28	127.5	11.2	88	187.3	16.4	48	247.1	21.6	
00.8	69	68.7	06.0	29	128.5	11.2	89	188.3	16.5	49	248.1	21.7	
00.9	70	69.7	06.1	30	129.5	11.3	90	189.3	16.6	50	249.0	21.8	
01.0	71	70.7	06.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.9	
01.0	72	71.7	06.3	132	131.5	11.5	92	191.3	16.7	52	251.0	22.0	
01.1	73	72.7	06.4	133	132.5	11.6	93	192.3	16.8	53	252.0	22.1	
01.2	74	73.7	06.4	134	133.5	11.7	94	193.3	16.9	54	253.0	22.1	
01.3	75	74.7	06.5	135	134.5	11.8	95	194.3	17.0	55	254.0	22.2	
01.4	76	75.7	06.6	136	135.5	11.9	96	195.3	17.1	56	255.0	22.3	
01.5	77	76.7	06.7	137	136.5	11.9	97	196.3	17.2	57	256.0	22.4	
01.6	78	77.7	06.8	138	137.5	12.0	98	197.3	17.3	58	257.0	22.5	
01.7	79	78.7	06.9	139	138.5	12.1	99	198.3	17.3	59	258.0	22.6	
01.7	80	79.7	07.0	140	139.5	12.2	200	199.2	17.4	60	259.0	22.7	
01.8	81	80.7	07.1	141	140.5	12.3	201	200.2	17.5	61	260.0	22.7	
01.9	82	81.7	07.1	142	141.5	12.4	02	201.2	17.6	62	261.0	22.8	
02.0	83	82.7	07.2	143	142.5	12.5	03	202.2	17.7	63	262.0	22.9	
02.1	84	83.7	07.3	144	143.5	12.6	04	203.2	17.8	64	263.0	23.0	
02.2	85	84.7	07.4	145	144.5	12.6	05	204.2	17.9	65	264.0	23.1	
02.3	86	85.7	07.5	146	145.5	12.7	06	205.2	18.0	66	265.0	23.2	
02.4	87	86.7	07.6	147	146.5	12.8	07	206.2	18.0	67	266.0	23.3	
02.5	88	87.7	07.7	148	147.5	12.9	08	207.2	18.1	68	267.0	23.4	
02.6	89	88.7	07.8	149	148.5	13.0	09	208.2	18.2	69	268.0	23.4	
02.6	90	89.7	07.9	150	149.5	13.1	10	209.2	18.3	70	269.0	23.5	
02.7	91	90.7	07.9	151	150.5	13.2	211	210.2	18.4	271	270.0	23.6	
02.8	92	91.6	08.0	152	151.5	13.2	12	211.2	18.5	72	271.0	23.7	
02.9	93	92.6	08.1	153	152.5	13.3	13	212.2	18.6	73	272.0	23.8	
03.0	94	93.6	08.2	154	153.5	13.4	14	213.2	18.7	74	273.0	23.9	
03.1	95	94.6	08.3	155	154.5	13.5	15	214.2	18.7	75	274.0	24.0	
03.1	96	95.6	08.4	156	155.5	13.6	16	215.2	18.8	76	274.9	24.1	
03.2	97	96.6	08.5	157	156.5	13.7	17	216.2	18.9	77	275.9	24.1	
03.3	98	97.6	08.5	158	157.5	13.8	18	217.2	19.0	78	276.9	24.2	
03.4	99	98.6	08.6	159	158.5	13.9	19	218.2	19.1	79	277.9	24.3	
03.5	100	99.6	08.7	160	159.5	13.9	20	219.2	19.2	80	278.9	24.4	
03.6	101	100.6	08.8	161	160.5	14.0	221	220.2	19.3	281	279.9	24.5	
03.7	02	101.6	08.9	162	161.5	14.1	22	221.2	19.3	82	280.9	24.6	
03.7	03	102.6	09.0	163	162.5	14.2	23	222.2	19.4	83	281.9	24.7	
03.8	04	103.6	09.1	164	163.5	14.3	24	223.2	19.5	84	282.9	24.8	
03.9	05	104.6	09.2	165	164.5	14.4	25	224.2	19.6	85	283.9	24.8	
04.0	06	105.6	09.2	166	165.5	14.5	26	225.2	19.7	86	284.9	24.9	
04.1	07	106.6	09.3	167	166.5	14.6	27	226.2	19.8	87	285.9	25.0	
04.2	08	107.6	09.4	168	167.5	14.6	28	227.2	19.9	88	286.9	25.1	
04.3	09	108.6	09.5	169	168.5	14.7	29	228.2	20.0	89	287.9	25.2	
04.4	10	109.6	09.6	170	169.5	14.8	30	229.2	20.0	90	288.9	25.3	
04.5	111	110.6	09.7	171	170.5	14.9	231	230.2	20.1	291	289.9	25.4	
04.6	12	111.6	09.8	172	171.5	15.0	32	231.2	20.2	92	290.9	25.4	
04.7	13	112.6	09.8	173	172.5	15.1	33	232.2	20.3	93	291.9	25.5	
04.8	14	113.6	09.9	174	173.5	15.2	34	233.2	20.4	94	292.9	25.6	
04.9	15	114.6	10.0	175	174.5	15.3	35	234.2	20.5	95	293.9	25.7	
05.0	16	115.6	10.1	176	175.5	15.3	36	235.2	20.6	96	294.9	25.8	
05.1	17	116.6	10.2	177	176.5	15.4	37	236.2	20.7	97	295.9	25.9	
05.2	18	117.6	10.3	178	177.5	15.5	38	237.2	20.7	98	296.9	26.0	
05.3	19	118.6	10.4	179	178.5	15.6	39	238.2	20.8	99	297.9	26.1	
05.4	20	119.6	10.5	180	179.5	15.7	40	239.2	20.9	300	298.9	26.1	
Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.

[For 5 Degrees.]

TABLE II.

Difference of Latitude and Departure for 6 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 1	61	60.7	06.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	02 0	00.2	62	61.7	06.5	122	121.3	12.8	182	181.0	19.0	242	240.7	25.3
3	03 0	00.3	63	62.7	06.6	123	122.3	12.9	183	182.0	19.1	243	241.7	25.4
4	04 0	00.4	64	63.6	06.7	124	123.3	13.0	184	183.0	19.2	244	242.7	25.5
5	05 0	00.5	65	64.6	06.8	125	124.3	13.1	185	184.0	19.3	245	243.7	25.6
6	06 0	00.6	66	65.6	06.9	126	125.3	13.2	186	185.0	19.4	246	244.7	25.7
7	07 0	00.7	67	66.6	07.0	127	126.3	13.3	187	186.0	19.5	247	245.6	25.8
8	08 0	00.8	68	67.6	07.1	128	127.3	13.4	188	187.0	19.7	248	246.6	25.9
9	09 0	00.9	69	68.6	07.2	129	128.3	13.5	189	188.0	19.8	249	247.6	26.0
10	09 9	01 0	70	69.6	07.3	130	129.3	13.6	190	189.0	19.9	250	248.6	26.1
11	10 9	01 1	71	70.6	07.4	131	130.3	13.7	191	190.0	20.0	251	249.6	26.2
12	11 9	01.3	72	71.6	07.5	132	131.3	13.8	192	190.9	20.1	252	250.6	26.3
13	12 9	01.4	73	72.6	07.6	133	132.3	13.9	193	191.9	20.2	253	251.6	26.4
14	13 9	01.5	74	73.6	07.7	134	133.3	14.0	194	192.9	20.3	254	252.6	26.5
15	14 9	01.6	75	74.6	07.8	135	134.3	14.1	195	193.9	20.4	255	253.6	26.6
16	15 9	01.7	76	75.6	07.9	136	135.3	14.2	196	194.9	20.5	256	254.6	26.7
17	16 9	01.8	77	76.6	08.0	137	136.3	14.3	197	195.9	20.6	257	255.6	26.8
18	17 9	01.9	78	77.6	08.2	138	137.3	14.4	198	196.9	20.7	258	256.6	26.9
19	18 9	02.0	79	78.6	08.3	139	138.3	14.5	199	197.9	20.8	259	257.6	27.0
20	19 9	02.1	80	79.6	08.4	140	139.3	14.6	200	198.9	20.9	260	258.6	27.1
21	20 9	02.2	81	80.6	08.5	141	140.3	14.7	201	199.9	21.0	261	259.6	27.2
22	21 9	02.3	82	81.6	08.6	142	141.3	14.8	202	200.9	21.1	262	260.6	27.3
23	22 9	02.4	83	82.6	08.7	143	142.3	14.9	203	201.9	21.2	263	261.6	27.4
24	23 9	02.5	84	83.6	08.8	144	143.3	15.0	204	202.9	21.3	264	262.6	27.5
25	24 9	02.6	85	84.6	08.9	145	144.3	15.1	205	203.9	21.4	265	263.6	27.6
26	25 9	02.7	86	85.6	09.0	146	145.3	15.2	206	204.9	21.5	266	264.6	27.7
27	26 9	02.8	87	86.6	09.1	147	146.3	15.3	207	205.9	21.6	267	265.6	27.8
28	27 9	02.9	88	87.6	09.2	148	147.3	15.4	208	206.9	21.7	268	266.6	27.9
29	28 9	03.0	89	88.6	09.3	149	148.3	15.5	209	207.9	21.8	269	267.6	28.0
30	29 9	03.1	90	89.6	09.4	150	149.3	15.6	210	208.9	21.9	270	268.6	28.1
31	30 9	03.2	91	90.6	09.5	151	150.3	15.7	211	209.9	22.0	271	269.6	28.2
32	31 9	03.3	92	91.6	09.6	152	151.3	15.8	212	210.9	22.1	272	270.6	28.3
33	32 9	03.4	93	92.6	09.7	153	152.3	15.9	213	211.9	22.2	273	271.6	28.4
34	33 9	03.5	94	93.6	09.8	154	153.3	16.0	214	212.9	22.3	274	272.6	28.5
35	34 9	03.6	95	94.6	09.9	155	154.3	16.1	215	213.9	22.4	275	273.6	28.6
36	35 9	03.7	96	95.6	10.0	156	155.3	16.2	216	214.9	22.5	276	274.6	28.7
37	36 9	03.8	97	96.6	10.1	157	156.3	16.3	217	215.9	22.6	277	275.6	28.8
38	37 9	03.9	98	97.6	10.2	158	157.3	16.4	218	216.9	22.7	278	276.6	28.9
39	38 9	04.0	99	98.6	10.3	159	158.3	16.5	219	217.9	22.8	279	277.6	29.0
40	39 9	04.1	100	99.6	10.4	160	159.3	16.6	220	218.9	22.9	280	278.6	29.1
41	40 9	04.2	101	100.6	10.5	161	160.3	16.7	221	219.9	23.0	281	279.6	29.2
42	41 9	04.3	102	101.6	10.6	162	161.3	16.8	222	220.9	23.1	282	280.6	29.3
43	42 9	04.4	103	102.6	10.7	163	162.3	16.9	223	221.9	23.2	283	281.6	29.4
44	43 9	04.5	104	103.6	10.8	164	163.3	17.0	224	222.9	23.3	284	282.6	29.5
45	44 9	04.6	105	104.6	10.9	165	164.3	17.1	225	223.9	23.4	285	283.6	29.6
46	45 9	04.7	106	105.6	11.0	166	165.3	17.2	226	224.9	23.5	286	284.6	29.7
47	46 9	04.8	107	106.6	11.1	167	166.3	17.3	227	225.9	23.6	287	285.6	29.8
48	47 9	04.9	108	107.6	11.2	168	167.3	17.4	228	226.9	23.7	288	286.6	29.9
49	48 9	05.0	109	108.6	11.3	169	168.3	17.5	229	227.9	23.8	289	287.6	30.0
50	49 9	05.1	110	109.6	11.4	170	169.3	17.6	230	228.9	23.9	290	288.6	30.1
51	50 9	05.2	111	110.6	11.5	171	170.3	17.7	231	229.9	24.0	291	289.6	30.2
52	51 9	05.3	112	111.6	11.6	172	171.3	17.8	232	230.9	24.1	292	290.6	30.3
53	52 9	05.4	113	112.6	11.7	173	172.3	17.9	233	231.9	24.2	293	291.6	30.4
54	53 9	05.5	114	113.6	11.8	174	173.3	18.0	234	232.9	24.3	294	292.6	30.5
55	54 9	05.6	115	114.6	11.9	175	174.3	18.1	235	233.9	24.4	295	293.6	30.6
56	55 9	05.7	116	115.6	12.0	176	175.3	18.2	236	234.9	24.5	296	294.6	30.7
57	56 9	05.8	117	116.6	12.1	177	176.3	18.3	237	235.9	24.6	297	295.6	30.8
58	57 9	05.9	118	117.6	12.2	178	177.3	18.4	238	236.9	24.7	298	296.6	30.9
59	58 9	06.0	119	118.6	12.3	179	178.3	18.5	239	237.9	24.8	299	297.6	31.0
60	59 9	06.1	120	119.6	12.4	180	179.3	18.6	240	238.9	24.9	300	298.6	31.1
61	60 9	06.2	121	120.6	12.5	181	180.3	18.7	241	239.9	25.0	301	299.6	31.2
62	61 9	06.3	122	121.6	12.6	182	181.3	18.8	242	240.9	25.1	302	300.6	31.3
63	62 9	06.4	123	122.6	12.7	183	182.3	18.9	243	241.9	25.2	303	301.6	31.4
64	63 9	06.5	124	123.6	12.8	184	183.3	19.0	244	242.9	25.3	304	302.6	31.5
65	64 9	06.6	125	124.6	12.9	185	184.3	19.1	245	243.9	25.4	305	303.6	31.6
66	65 9	06.7	126	125.6	13.0	186	185.3	19.2	246	244.9	25.5	306	304.6	31.7
67	66 9	06.8	127	126.6	13.1	187	186.3	19.3	247	245.9	25.6	307	305.6	31.8
68	67 9	06.9	128	127.6	13.2	188	187.3	19.4	248	246.9	25.7	308	306.6	31.9
69	68 9	07.0	129	128.6	13.3	189	188.3	19.5	249	247.9	25.8	309	307.6	32.0
70	69 9	07.1	130	129.6	13.4	190	189.3	19.6	250	248.9	25.9	310	308.6	32.1
71	70 9	07.2	131	130.6	13.5	191	190.3	19.7	251	249.9	26.0	311	309.6	32.2
72	71 9	07.3	132	131.6	13.6	192	191.3	19.8	252	250.9	26.1	312	310.6	32.3
73	72 9	07.4	133	132.6	13.7	193	192.3	19.9	253	251.9	26.2	313	311.6	32.4
74	73 9	07.5	134	133.6	13.8	194	193.3	20.0	254	252.9	26.3	314	312.6	32.5
75	74 9	07.6	135	134.6	13.9	195	194.3	20.1	255	253.9	26.4	315	313.6	32.6
76	75 9	07.7	136	135.6	14.0	196	195.3	20.2	256	254.9	26.5	316	314.6	32.7
77	76 9	07.8	137	136.6	14.1	197	196.3	20.3	257	255.9	26.6	317	315.6	32.8
78	77 9	07.9	138	137.6	14.2	198	197.3	20.4	258	256.9	26.7	318	316.6	32.9
79	78 9	08.0	139	138.6	14.3	199	198.3	20.5	259	257.9	26.8	319	317.6	33.0
80	79 9	08.1	140	139.6	14.4	200	199.3	20.6	260	258.9	26.9	320	318.6	33.1
81	80 9	08.2	141	140.6	14.5	201	200.3	20.7	261	259.9	27.0	321	319.6	33.2
82	81 9	08.3	142	141.6	14.6	202	201.3	20.8	262	260.9	27.1	322	320.6	33.3
83	82 9	08.4	143	142.6	14.7	203	202.3	20.9	263	261.9	27.2	323	321.6	33.4
84	83 9	08.5	144	143.6	14.8	204	203.3	21.0	264	262.9	27.3	324	322.6	33.5
85	84 9	08.6	145	144.6	14.9	205	204.3	21.1	265	263.9	27.4	325	323.6	33.6
86	85 9	08.7	146	145.6	15.0	206	205.3	21.2	266	264.9	27.5	326	324.6	33.7
87	86 9	08.8	147	146.6	15.1	207	206.3	21.3	267	265.9	27.6	327	325.6	33.8
88	87 9	08.9	148	147.6	15.2	208	207.3	21.4	268	266.9	27.7	328	326.6	33.9
89	88 9	09.0	149	148.6	15.3	209	208.3	21.5	269	267.9				

TABLE II.

23

Difference of Latitude and Departure for 7 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 6	00.1	61	60 5	07.4	121	120.1	14.7	181	179 7	22.1	241	239 2	29.4
2	02 0	00.2	62	61 5	07.6	122	121 1	14.9	82	180 6	22.2	242	240 2	29.5
3	03 0	00.3	63	62 5	07.7	123	122 1	15.0	83	181 6	22.3	243	241 2	29.6
4	04 0	00.5	64	63 5	07.8	124	123 1	15.1	84	182 6	22.4	244	242 2	29.7
5	05 0	00.6	65	64 5	07.9	125	124 1	15.2	85	183 6	22.5	245	243 2	29.9
6	06 0	00.7	66	65 5	08.0	126	125 1	15.4	86	184 6	22.7	246	244 2	30.0
7	06 9	00.9	67	66 5	08.2	127	126 1	15.5	87	185 6	22.8	247	245 2	30.1
8	07 9	01.0	68	67 5	08.3	128	127 0	15.6	88	186 6	22.9	248	246 2	30.2
9	08 9	01.1	69	68 5	08.4	129	128 0	15.7	89	187 6	23.0	249	247 1	30.3
10	09 9	01.2	70	69 5	08.5	130	129 0	15.8	90	188 6	23.1	250	248 1	30.5
11	10 9	01.3	71	70 5	08.7	131	130 0	16.0	191	189 6	23.3	251	249 1	30.6
12	11 9	01.5	72	71 5	08.8	132	131 0	16.1	92	190 6	23.4	252	250 1	30.7
13	12 9	01.6	73	72 5	08.9	133	132 0	16.2	93	191 6	23.5	253	251 1	30.8
14	13 9	01.7	74	73 5	09.0	134	133 0	16.3	94	192 6	23.6	254	252 1	31.0
15	14 9	01.8	75	74 5	09.1	135	134 0	16.5	95	193 6	23.8	255	253 1	31.1
16	15 9	01.9	76	75 5	09.3	136	135 0	16.6	96	194 6	23.9	256	254 1	31.2
17	16 9	02.1	77	76 5	09.4	137	136 0	16.7	97	195 6	24.0	257	255 1	31.3
18	17 9	02.2	78	77 5	09.5	138	137 0	16.8	98	196 6	24.1	258	256 1	31.4
19	18 9	02.3	79	78 5	09.6	139	138 0	16.9	99	197 6	24.3	259	257 1	31.6
20	19 9	02.4	80	79 5	09.7	140	139 0	17.1	200	198 6	24.4	260	258 1	31.7
21	20 8	02.6	81	80 4	09.9	141	139 0	17.2	201	199 6	24.5	261	259 1	31.8
22	21 8	02.7	82	81 4	10.0	142	140 9	17.3	02	200 5	24.6	262	260 0	31.9
23	22 8	02.8	83	82 4	10.1	143	141 9	17.4	03	201 5	24.7	263	261 0	32.1
24	23 8	02.9	84	83 4	10.2	144	142 9	17.5	04	202 5	24.9	264	262 0	32.2
25	24 8	03.0	85	84 4	10.4	145	143 9	17.7	05	203 5	25.0	265	263 0	32.3
26	25 8	03.1	86	85 4	10.5	146	144 9	17.8	06	204 5	25.1	266	264 0	32.4
27	26 8	03.3	87	86 4	10.6	147	145 9	17.9	07	205 5	25.2	267	265 0	32.5
28	27 8	03.4	88	87 3	10.7	148	146 9	18.0	08	206 4	25.3	268	266 0	32.7
29	28 8	03.6	89	88 3	10.8	149	147 9	18.2	09	207 4	25.6	269	267 0	32.8
30	29 8	03.7	90	89 3	11.0	150	148 9	18.3	10	208 4	25.6	270	268 0	32.9
31	30 8	03.8	91	90 3	11.1	151	149 9	18.4	211	209 4	25.7	271	269 0	33.0
32	31 8	03.9	92	91 3	11.2	152	150 9	18.5	12	210 4	25.8	272	270 0	33.1
33	32 8	04.0	93	92 3	11.3	153	151 9	18.6	13	211 4	26.0	273	271 0	33.3
34	33 7	04.1	94	93 3	11.5	154	152 9	18.8	14	212 4	26.1	274	272 0	33.4
35	34 7	04.3	95	94 3	11.6	155	153 8	18.9	15	213 4	26.2	275	273 0	33.5
36	35 7	04.4	96	95 3	11.7	156	154 8	19.0	16	214 4	26.3	276	274 0	33.6
37	36 7	04.5	97	96 3	11.8	157	155 8	19.1	17	215 4	26.4	277	275 0	33.8
38	37 7	04.6	98	97 3	11.9	158	156 8	19.3	18	216 4	26.6	278	276 0	33.9
39	38 7	04.8	99	98 3	12.1	159	157 8	19.4	19	217 4	26.7	279	277 0	34.0
40	39 7	04.9	100	99 3	12.2	160	158 8	19.5	20	218 4	26.8	280	278 0	34.1
41	40 7	05.0	101	100 2	12.3	161	159 8	19.6	221	219 4	26.9	281	278 9	34.2
42	41 7	05.1	02	101 2	12.4	162	160 8	19.7	22	220 3	27.1	282	279 9	34.4
43	42 7	05.2	03	102 2	12.6	163	161 8	19.9	23	221 3	27.2	283	280 9	34.5
44	43 7	05.4	04	103 2	12.7	164	162 8	20.0	24	222 3	27.3	284	281 9	34.6
45	44 7	05.5	05	104 2	12.8	165	163 8	20.1	25	223 3	27.4	285	282 9	34.7
46	45 7	05.6	06	105 2	12.9	166	164 8	20.2	26	224 3	27.5	286	283 9	34.9
47	46 6	05.7	07	106 2	13.0	167	165 8	20.4	27	225 3	27.7	287	284 9	35.0
48	47 6	05.8	08	107 2	13.2	168	166 7	20.5	28	226 3	27.8	288	285 9	35.1
49	48 6	06.0	09	108 2	13.3	169	167 7	20.6	29	227 3	27.9	289	286 8	35.2
50	49 6	06.1	10	109 2	13.4	170	168 7	20.7	30	228 3	28.0	290	287 8	35.3
51	50 6	06.2	111	110 2	13.5	171	169 7	20.8	231	229 3	28.1	291	288 8	35.5
52	51 6	06.3	12	111 2	13.6	172	170 7	21.0	23	230 3	28.3	292	289 8	35.6
53	52 6	06.5	13	112 2	13.8	173	171 7	21.1	24	231 3	28.4	293	290 8	35.7
54	53 6	06.6	14	113 2	13.9	174	172 7	21.2	34	232 3	28.5	294	291 8	35.8
55	54 6	06.7	15	114 1	14.0	175	173 7	21.3	35	233 3	28.6	295	292 8	36.0
56	55 6	06.8	16	115 1	14.1	176	174 7	21.4	36	234 3	28.8	296	293 8	36.1
57	56 6	06.9	17	116 1	14.3	177	175 7	21.6	37	235 3	28.9	297	294 8	36.2
58	57 6	07.1	18	117 1	14.4	178	176 7	21.7	38	236 3	29.0	298	295 8	36.3
59	58 6	07.2	19	118 1	14.5	179	177 7	21.8	39	237 3	29.1	299	296 8	36.4
60	59 6	07.3	20	119 1	14.6	180	178 7	21.9	40	238 3	29.2	300	297 8	36.6

[For 83 Degrees.]

TABLE II.

Difference of Latitude and Departure for 8 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.4	08.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	02.0	00.3	62	61.4	08.6	22	120.8	17.0	82	180.2	25.3	42	239.6	33.7
3	03.0	00.4	63	62.4	08.8	23	121.8	17.1	83	181.2	25.5	43	240.6	33.8
4	04.0	00.6	64	63.4	08.9	24	122.8	17.3	84	182.2	25.6	44	241.6	34.0
5	05.0	00.7	65	64.4	09.0	25	123.8	17.4	85	183.2	25.7	45	242.6	34.1
6	05.9	00.8	66	65.4	09.2	26	124.8	17.5	86	184.2	25.9	46	243.6	34.2
7	06.9	01.0	67	66.3	09.3	27	125.8	17.7	87	185.2	26.0	47	244.6	34.4
8	07.9	01.1	68	67.3	09.5	28	126.8	17.8	88	186.2	26.2	48	245.6	34.5
9	08.9	01.3	69	68.3	09.6	29	127.7	18.0	89	187.2	26.3	49	246.6	34.7
10	09.9	01.4	70	69.3	09.7	30	128.7	18.1	90	188.2	26.4	50	247.6	34.8
11	10.9	01.5	71	70.3	09.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	01.7	72	71.3	10.0	32	130.7	18.4	92	190.1	26.7	52	249.5	35.1
13	12.9	01.8	73	72.3	10.2	33	131.7	18.5	93	191.1	26.9	53	250.5	35.2
14	13.9	01.9	74	73.3	10.3	34	132.7	18.6	94	192.1	27.0	54	251.5	35.3
15	14.9	02.1	75	74.3	10.4	35	133.7	18.8	95	193.1	27.1	55	252.5	35.5
16	15.8	02.2	76	75.3	10.6	36	134.7	18.9	96	194.1	27.3	56	253.5	35.6
17	16.8	02.4	77	76.3	10.7	37	135.7	19.1	97	195.1	27.4	57	254.5	35.8
18	17.8	02.5	78	77.2	10.9	38	136.7	19.2	98	196.1	27.6	58	255.5	35.9
19	18.8	02.6	79	78.2	11.0	39	137.7	19.3	99	197.1	27.7	59	256.5	36.0
20	19.8	02.8	80	79.2	11.1	40	138.6	19.5	200	198.1	27.8	60	257.5	36.2
21	20.8	02.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	03.1	82	81.2	11.4	42	140.6	19.8	02	200.0	28.1	62	259.5	36.5
23	22.8	03.2	83	82.2	11.6	43	141.6	19.9	03	201.0	28.3	63	260.4	36.6
24	23.8	03.3	84	83.2	11.7	44	142.6	20.0	04	202.0	28.4	64	261.4	36.7
25	24.8	03.5	85	84.2	11.8	45	143.6	20.2	05	203.0	28.5	65	262.4	36.9
26	25.7	03.6	86	85.2	12.0	46	144.6	20.3	06	204.0	28.7	66	263.4	37.0
27	26.7	03.8	87	86.2	12.1	47	145.6	20.5	07	205.0	28.8	67	264.4	37.2
28	27.7	03.9	88	87.1	12.2	48	146.6	20.6	08	206.0	28.9	68	265.4	37.3
29	28.7	04.0	89	88.1	12.4	49	147.5	20.7	09	207.0	29.1	69	266.4	37.4
30	29.7	04.2	90	89.1	12.5	50	148.5	20.9	10	208.0	29.2	70	267.4	37.6
31	30.7	04.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	04.5	92	91.1	12.8	52	150.5	21.2	12	209.9	29.5	72	269.4	37.9
33	32.7	04.6	93	92.1	12.9	53	151.5	21.3	13	210.9	29.6	73	270.3	38.0
34	33.7	04.7	94	93.1	13.1	54	152.5	21.4	14	211.9	29.8	74	271.3	38.1
35	34.7	04.9	95	94.1	13.2	55	153.5	21.6	15	212.9	29.9	75	272.3	38.3
36	35.6	05.0	96	95.1	13.4	56	154.5	21.7	16	213.9	30.1	76	273.3	38.4
37	36.6	05.1	97	96.1	13.5	57	155.5	21.9	17	214.9	30.2	77	274.3	38.6
38	37.6	05.3	98	97.0	13.6	58	156.5	22.0	18	215.9	30.3	78	275.3	38.7
39	38.6	05.4	99	98.0	13.8	59	157.5	22.1	19	216.9	30.5	79	276.3	38.8
40	39.6	05.6	100	99.0	13.9	60	158.4	22.3	20	217.9	30.6	80	277.3	39.0
41	40.6	05.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	05.8	02	101.0	14.2	62	160.4	22.5	22	219.8	30.9	82	279.3	39.2
43	42.6	06.0	03	102.0	14.3	63	161.4	22.7	23	220.8	31.0	83	280.2	39.4
44	43.6	06.1	04	103.0	14.5	64	162.4	22.8	24	221.8	31.2	84	281.2	39.5
45	44.6	06.3	05	104.0	14.6	65	163.4	23.0	25	222.8	31.3	85	282.2	39.7
46	45.6	06.4	06	105.0	14.8	66	164.4	23.1	26	223.8	31.5	86	283.2	39.8
47	46.5	06.5	07	106.0	14.9	67	165.4	23.2	27	224.8	31.6	87	284.2	39.9
48	47.5	06.7	08	106.9	15.0	68	166.4	23.4	28	225.8	31.7	88	285.2	40.1
49	48.5	06.8	09	107.9	15.2	69	167.4	23.5	29	226.8	31.9	89	286.2	40.2
50	49.5	07.0	110	108.9	15.3	70	168.3	23.7	30	227.8	32.0	90	287.2	40.4
51	50.5	07.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	07.2	12	110.9	15.6	72	170.3	23.9	32	229.7	32.3	92	289.2	40.6
53	52.5	07.4	13	111.9	15.7	73	171.3	24.1	33	230.7	32.4	93	290.1	40.8
54	53.5	07.5	14	112.9	15.9	74	172.3	24.2	34	231.7	32.6	94	291.1	40.9
55	54.5	07.7	15	113.9	16.0	75	173.3	24.4	35	232.7	32.7	95	292.1	41.1
56	55.5	07.8	16	114.9	16.1	76	174.3	24.5	36	233.7	32.8	96	293.1	41.2
57	56.4	07.9	17	115.9	16.3	77	175.3	24.6	37	234.7	33.0	97	294.1	41.3
58	57.4	08.1	18	116.9	16.4	78	176.3	24.8	38	235.7	33.1	98	295.1	41.5
59	58.4	08.2	19	117.8	16.6	79	177.3	24.9	39	236.7	33.3	99	296.1	41.6
60	59.4	08.4	20	118.8	16.7	80	178.2	25.1	40	237.7	33.4	300	297.1	41.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 82 Degrees.

TABLE II.

25

Difference of Latitude and Departure for 9 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.2	09.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	02.0	00.3	62	61.2	09.7	22	120.5	19.1	82	179.8	28.5	42	239.0	37.9
3	03.0	00.5	63	62.2	09.9	23	121.5	19.2	83	180.7	28.6	43	240.0	38.0
4	04.0	00.6	64	63.2	10.0	24	122.5	19.4	84	181.7	28.8	44	241.0	38.2
5	04.9	00.8	65	64.2	10.2	25	123.5	19.6	85	182.7	28.9	45	242.0	38.3
6	05.9	00.9	66	65.2	10.3	26	124.4	19.7	86	183.7	29.1	46	243.0	38.5
7	06.9	01.1	67	66.2	10.5	27	125.4	19.9	87	184.7	29.3	47	244.0	38.6
8	07.9	01.3	68	67.2	10.6	28	126.4	20.0	88	185.7	29.4	48	244.9	38.8
9	08.9	01.4	69	68.2	10.8	29	127.4	20.2	89	186.7	29.6	49	245.9	39.0
10	09.9	01.6	70	69.1	11.0	30	128.4	20.3	90	187.7	29.7	50	246.9	39.1
11	10.9	01.7	71	70.1	11.1	131	129.4	20.5	191	188.6	29.9	251	247.9	39.3
12	11.9	01.9	72	71.1	11.3	32	130.4	20.6	92	189.6	30.0	52	248.9	39.4
13	12.8	02.0	73	72.1	11.4	33	131.4	20.8	93	190.6	30.2	53	249.9	39.6
14	13.8	02.2	74	73.1	11.6	34	132.4	21.0	94	191.6	30.3	54	250.9	39.7
15	14.8	02.3	75	74.1	11.7	35	133.3	21.1	95	192.6	30.5	55	251.9	39.9
16	15.8	02.5	76	75.1	11.9	36	134.3	21.3	96	193.6	30.7	56	252.8	40.0
17	16.8	02.7	77	76.1	12.0	37	135.3	21.4	97	194.6	30.8	57	253.8	40.2
18	17.8	02.8	78	77.0	12.2	38	136.3	21.6	98	195.6	31.0	58	254.8	40.4
19	18.8	03.0	79	78.0	12.4	39	137.3	21.7	99	196.5	31.1	59	255.8	40.5
20	19.8	03.1	80	79.0	12.5	40	138.3	21.9	200	197.5	31.3	60	256.8	40.7
21	20.7	03.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	03.4	82	81.0	12.8	42	140.3	22.2	02	199.5	31.6	62	258.8	41.0
23	22.7	03.6	83	82.0	13.0	43	141.2	22.4	03	200.5	31.8	63	259.8	41.1
24	23.7	03.8	84	83.0	13.1	44	142.2	22.5	04	201.5	31.9	64	260.7	41.3
25	24.7	03.9	85	84.0	13.3	45	143.2	22.7	05	202.5	32.1	65	261.7	41.5
26	25.7	04.1	86	84.9	13.5	46	144.2	22.8	06	203.5	32.2	66	262.7	41.6
27	26.7	04.2	87	85.9	13.6	47	145.2	23.0	07	204.5	32.4	67	263.7	41.8
28	27.7	04.4	88	86.9	13.8	48	146.2	23.2	08	205.4	32.5	68	264.7	41.9
29	28.6	04.5	89	87.9	13.9	49	147.2	23.3	09	206.4	32.7	69	265.7	42.1
30	29.6	04.7	90	88.9	14.1	50	148.2	23.5	10	207.4	32.9	70	266.7	42.2
31	30.6	04.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	05.0	92	90.9	14.4	52	150.1	23.8	12	209.4	33.2	72	268.7	42.6
33	32.6	05.2	93	91.9	14.5	53	151.1	23.9	13	210.4	33.3	73	269.6	42.7
34	33.6	05.3	94	92.8	14.7	54	152.1	24.1	14	211.4	33.5	74	270.6	42.9
35	34.6	05.5	95	93.8	14.9	55	153.1	24.2	15	212.4	33.6	75	271.6	43.0
36	35.6	05.6	96	94.8	15.0	56	154.1	24.4	16	213.3	33.8	76	272.6	43.2
37	36.5	05.8	97	95.8	15.2	57	155.1	24.6	17	214.3	33.9	77	273.6	43.3
38	37.5	05.9	98	96.8	15.3	58	156.1	24.7	18	215.3	34.1	78	274.6	43.5
39	38.5	06.1	99	97.8	15.5	59	157.0	24.9	19	216.3	34.3	79	275.6	43.6
40	39.5	06.3	100	98.8	15.6	60	158.0	25.0	20	217.3	34.4	80	276.6	43.8
41	40.5	06.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	44.0
42	41.5	06.6	02	100.7	16.0	62	160.0	25.3	22	219.3	34.7	82	278.5	44.1
43	42.5	06.7	03	101.7	16.1	63	161.0	25.5	23	220.3	34.9	83	279.5	44.3
44	43.5	06.9	04	102.7	16.3	64	162.0	25.7	24	221.2	35.0	84	280.5	44.4
45	44.4	07.0	05	103.7	16.4	65	163.0	25.8	25	222.2	35.2	85	281.5	44.6
46	45.4	07.2	06	104.7	16.6	66	164.0	26.0	26	223.2	35.4	86	282.5	44.7
47	46.4	07.4	07	105.7	16.7	67	164.9	26.1	27	224.2	35.5	87	283.5	44.9
48	47.4	07.5	08	106.7	16.9	68	165.9	26.3	28	225.2	35.7	88	284.5	45.1
49	48.4	07.7	09	107.7	17.1	69	166.9	26.4	29	226.2	35.8	89	285.4	45.2
50	49.4	07.8	10	108.6	17.2	70	167.9	26.6	30	227.2	36.0	90	286.4	45.4
51	50.4	08.0	111	109.6	17.4	171	168.9	26.8	231	228.2	36.1	291	287.4	45.5
52	51.4	08.1	12	110.6	17.5	72	169.9	26.9	32	229.1	36.3	92	288.4	45.7
53	52.3	08.3	13	111.6	17.7	73	170.9	27.1	33	230.1	36.4	93	289.4	45.8
54	53.3	08.4	14	112.6	17.8	74	171.9	27.2	34	231.1	36.6	94	290.4	46.0
55	54.3	08.6	15	113.6	18.0	75	172.8	27.4	35	232.1	36.8	95	291.4	46.1
56	55.3	08.8	16	114.6	18.1	76	173.8	27.5	36	233.1	36.9	96	292.4	46.3
57	56.3	08.9	17	115.6	18.3	77	174.8	27.7	37	234.1	37.1	97	293.3	46.5
58	57.3	09.1	18	116.6	18.5	78	175.8	27.8	38	235.1	37.2	98	294.3	46.6
59	58.3	09.2	19	117.6	18.6	79	176.8	28.0	39	236.1	37.4	99	295.3	46.8
60	59.3	09.4	20	118.6	18.8	80	177.8	28.2	40	237.0	37.5	300	296.3	46.9
Lat.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 81 Degrees.]

TABLE II.

Difference of Latitude and Departure for 10 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	60 1	10.6	121	119 2	21.0	181	178 3	31.4	241	237 3	41.8
2	02 0	00 3	62	61 1	10.8	22	120 1	21.2	82	179.2	31.6	42	238 3	42.0
3	03 0	00 5	63	62 0	10.9	23	121 1	21.4	83	180.2	31.8	43	239 3	42.2
4	03 9	00 7	64	63 0	11.1	24	122 1	21.5	84	181 2	32.0	44	240 3	42.4
5	04 9	00 9	65	64.0	11.3	25	123 1	21.7	85	182 2	32.1	45	241 3	42.5
6	05 9	01.0	66	65.0	11.5	26	124.1	21.9	86	183.2	32.3	46	242 3	42.7
7	06 9	01.2	67	66 0	11.6	27	125 1	22.1	87	184.2	32.5	47	243 3	42.9
8	07 9	01.4	68	67 0	11.8	28	126 1	22.2	88	185.1	32.6	48	244 2	43.1
9	08 9	01.6	69	68 0	12.0	29	127.0	22.4	89	186 1	32.8	49	245.2	43.2
10	09 8	01.7	70	68 9	12.2	30	128 0	22.6	90	187.1	33.0	50	246 2	43.4
11	10 8	01.9	71	69 9	12.3	131	129 0	22.7	191	188 1	33.2	251	247 2	43.6
12	11.8	02.1	72	70 9	12.5	32	130 0	22.9	92	189.1	33.3	52	248 2	43.8
13	12 8	02.3	73	71 9	12.7	33	131.0	23.1	93	190.1	33.5	53	249 2	43.9
14	13 8	02.4	74	72 9	12.8	34	132 0	23.3	94	191.1	33.7	54	250 1	44.1
15	14 8	02.6	75	73 0	13.0	35	132.9	23.4	95	192 0	33.9	55	251 1	44.3
16	15 8	02.8	76	74 8	13.2	36	133.9	23.6	96	193 0	34.0	56	252 1	44.5
17	16 7	03.0	77	75 8	13.4	37	134 9	23.8	97	194 0	34.2	57	253.1	44.6
18	17 7	03.1	78	76 8	13.5	38	135 9	24.0	98	195 0	34.4	58	254 1	44.8
19	18.7	03.3	79	77 8	13.7	39	136 9	24.1	99	196.0	34.6	59	255 1	45.0
20	19 7	03.5	80	78 8	13.9	40	137.9	24.3	200	197.0	34.7	60	256 1	45.1
21	20 7	03.6	81	79 8	14.1	141	138 9	24.5	201	197.9	34.9	261	257 0	45.3
22	21 7	03.8	82	80 8	14.2	42	139 8	24.7	02	198 9	35.1	62	258 0	45.5
23	22 7	04.0	83	81 7	14.4	43	140 8	24.8	03	199.9	35.3	63	259 0	45.7
24	23 6	04.2	84	82 7	14.6	44	141.8	25.0	04	200 9	35.4	64	260 0	45.8
25	24 6	04.3	85	83 7	14.8	45	142 8	25.2	05	201.9	35.6	65	261.0	46.0
26	25 6	04.5	86	84 7	14.9	46	143 8	25.4	06	202 9	35.8	66	262.0	46.2
27	26 6	04.7	87	85.7	15.1	47	144 8	25.5	07	203 9	35.9	67	262.9	46.4
28	27 6	04.9	88	86.7	15.3	48	145.8	25.7	08	204 8	36.1	68	263 9	46.5
29	28 6	06.0	89	87 6	15.5	49	146.7	25.9	09	205 8	36.3	69	264.9	46.7
30	29 5	06.2	90	88 6	15.6	50	147 7	26.0	10	206.8	36.5	70	265 9	46.9
31	30 5	05.4	91	89 6	15.8	151	148 7	26.2	211	207.8	36.6	271	266.9	47.1
32	31 5	05.6	92	90 6	16.0	52	149 7	26.4	12	208 8	36.8	72	267.9	47.2
33	32.5	05.7	93	91 6	16.1	53	150 7	26.6	13	209 8	37.0	73	268 9	47.4
34	33.5	05.9	94	92 6	16.3	54	151 7	26.7	14	210.7	37.2	74	269 8	47.6
35	34.6	06.1	95	93 6	16.5	55	152.6	26.9	15	211 7	37.3	75	270 8	47.8
36	35 5	06.3	96	94 5	16.7	56	153 6	27.1	16	212 7	37.5	76	271 8	47.9
37	36.4	06.4	97	95 5	16.8	57	154 6	27.3	17	213.7	37.7	77	272 8	48.1
38	37 4	06.6	98	96.5	17.0	58	155 6	27.4	18	214 7	37.9	78	273.8	48.3
39	38 4	06.8	99	97.5	17.2	59	156.6	27.6	19	215.7	38.0	79	274.8	48.4
40	39 4	06.9	100	98 5	17.4	60	157 6	27.8	20	216 7	38.2	80	275 7	48.6
41	40 4	07.1	101	99 5	17.5	161	158 6	28.0	221	217 6	38.4	281	276 7	48.8
42	41.4	07.3	02	100 5	17.7	62	159.5	28.1	22	218 6	38.5	82	277 7	49.0
43	42 3	07.5	03	101.4	17.9	63	160.5	28.3	23	219 6	38.7	83	278 7	49.1
44	43 3	07.6	04	102.4	18.1	64	161.5	28.5	24	220.6	38.9	84	279 7	49.3
45	44 3	07.8	05	103.4	18.2	65	162 5	28.7	25	221 6	39.1	85	280.7	49.5
46	45 3	08.0	06	104.4	18.4	66	163.5	28.8	26	222 6	39.2	86	281.7	49.7
47	46 3	08.2	07	105.4	18.6	67	164 5	29.0	27	223 6	39.4	87	282 6	49.8
48	47.3	08.3	08	106.4	18.8	68	165 4	29.2	28	224 5	39.6	88	283 6	50.0
49	48 3	08.5	09	107 3	18.9	69	166 4	29.3	29	225.5	39.8	89	284 6	50.2
50	49 2	08.7	10	108 3	19.1	70	167.4	29.5	30	226 5	39.9	90	285 6	50.4
51	50 2	08.9	111	109 3	19.3	171	168 4	29.7	231	227 5	40.1	291	286.6	50.6
52	51 2	09.0	12	110 3	19.4	72	169.4	29.9	32	228 5	40.3	92	287.6	50.7
53	52.2	09.2	13	111 3	19.6	73	170.4	30.0	33	229 5	40.5	93	288 5	50.9
54	53 2	09.4	14	112.3	19.8	74	171.4	30.2	34	230 4	40.6	94	289 5	51.1
55	54 2	09.6	15	113.3	20.0	75	172.3	30.4	35	231 4	40.8	95	290 5	51.2
56	55.1	09.7	16	114 2	20.1	76	173 3	30.6	36	232 4	41.0	96	291 5	51.4
57	56.1	09.9	17	115 2	20.3	77	174 3	30.7	37	233 4	41.2	97	292.5	51.6
58	57.1	10.1	18	116 2	20.5	78	175.3	30.9	38	234 4	41.3	98	293 5	51.7
59	58 1	10.2	19	117.2	20.7	79	176.3	31.1	39	235 4	41.5	99	294.5	51.9
60	59.1	10.4	20	118.2	20.9	80	177 3	31.3	40	236 4	41.7	300	295.5	52.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 80 Degrees.]

TABLE II.

Difference of Latitude and Departure for 11 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	59 9	11 6	121	118 8	23 1	181	177 7	34 3	241	236 6	46 0
2	02 0	00 4	62	60 9	11 8	122	119 8	23 3	182	178 7	34 7	242	237 6	46 2
3	03 0	00 6	63	61 8	12 0	123	120 7	23 5	183	179 6	34 9	243	238 5	46 4
4	04 0	00 8	64	62 8	12 2	124	121 7	23 7	184	180 6	35 1	244	239 4	46 6
5	05 0	01 0	65	63 8	12 4	125	122 7	23 9	185	181 6	35 3	245	240 3	46 7
6	06 0	01 1	66	64 8	12 6	126	123 7	24 0	186	182 6	35 5	246	241 2	46 9
7	07 0	01 3	67	65 8	12 8	127	124 7	24 2	187	183 6	35 7	247	242 1	47 1
8	08 0	01 5	68	66 8	13 0	128	125 6	24 4	188	184 6	35 9	248	243 0	47 3
9	09 0	01 7	69	67 7	13 2	129	126 6	24 6	189	185 6	36 1	249	244 0	47 5
10	10 0	01 9	70	68 7	13 4	130	127 6	24 8	190	186 5	36 3	250	245 0	47 7
11	10 8	02 1	71	69 7	13 5	131	128 6	25 0	191	187 5	36 4	251	246 0	47 9
12	11 8	02 3	72	70 7	13 7	132	129 6	25 2	192	188 5	36 6	252	247 0	48 1
13	12 8	02 5	73	71 7	13 9	133	130 6	25 4	193	189 5	36 8	253	248 0	48 3
14	13 7	02 7	74	72 6	14 1	134	131 5	25 6	194	190 4	37 0	254	249 0	48 5
15	14 7	02 9	75	73 6	14 3	135	132 5	25 8	195	191 4	37 2	255	250 0	48 7
16	15 7	03 1	76	74 6	14 5	136	133 5	26 0	196	192 4	37 4	256	251 0	48 8
17	16 7	03 2	77	75 6	14 7	137	134 5	26 1	197	193 4	37 6	257	252 0	49 0
18	17 7	03 4	78	76 6	14 9	138	135 5	26 3	198	194 4	37 8	258	253 0	49 2
19	18 7	03 6	79	77 5	15 1	139	136 4	26 5	199	195 3	38 0	259	254 0	49 4
20	19 6	03 8	80	78 5	15 3	140	137 4	26 7	200	196 3	38 2	260	255 0	49 6
21	20 6	04 0	81	79 5	15 5	141	138 4	26 9	201	197 3	38 4	261	256 0	49 8
22	21 6	04 2	82	80 5	15 6	142	139 4	27 1	202	198 3	38 5	262	257 0	50 0
23	22 6	04 4	83	81 5	15 8	143	140 4	27 3	203	199 3	38 7	263	258 0	50 2
24	23 6	04 6	84	82 5	16 0	144	141 4	27 5	204	200 3	38 9	264	259 0	50 4
25	24 6	04 8	85	83 4	16 2	145	142 3	27 7	205	201 2	39 1	265	260 0	50 6
26	25 5	05 0	86	84 4	16 4	146	143 3	27 9	206	202 2	39 3	266	261 0	50 8
27	26 5	05 2	87	85 4	16 6	147	144 3	28 0	207	203 2	39 5	267	262 0	50 9
28	27 5	05 3	88	86 4	16 8	148	145 3	28 2	208	204 2	39 7	268	263 0	51 1
29	28 5	05 5	89	87 4	17 0	149	146 3	28 4	209	205 2	39 9	269	264 0	51 3
30	29 4	05 7	90	88 3	17 2	150	147 2	28 6	210	206 1	40 1	270	265 0	51 5
31	30 4	05 9	91	89 3	17 4	151	148 2	28 8	211	207 1	40 3	271	266 0	51 7
32	31 4	06 1	92	90 3	17 6	152	149 2	29 0	212	208 1	40 5	272	267 0	51 9
33	32 4	06 3	93	91 3	17 7	153	150 2	29 2	213	209 1	40 6	273	268 0	52 1
34	33 4	06 5	94	92 3	17 9	154	151 2	29 4	214	210 1	40 8	274	269 0	52 3
35	34 4	06 7	95	93 3	18 1	155	152 2	29 6	215	211 0	41 0	275	270 0	52 5
36	35 3	06 9	96	94 2	18 3	156	153 1	29 8	216	212 0	41 2	276	270 0	52 7
37	36 3	07 1	97	95 2	18 5	157	154 1	30 0	217	213 0	41 4	277	271 0	52 9
38	37 3	07 3	98	96 2	18 7	158	155 1	30 1	218	214 0	41 6	278	272 0	53 0
39	38 3	07 4	99	97 2	18 9	159	156 1	30 3	219	215 0	41 8	279	273 0	53 2
40	39 3	07 6	100	98 2	19 1	160	157 1	30 5	220	216 0	42 0	280	274 0	53 4
41	40 2	07 8	101	99 1	19 3	161	158 0	30 7	221	216 9	42 2	281	275 0	53 6
42	41 2	08 0	102	100 1	19 5	162	159 0	30 9	222	217 9	42 4	282	276 0	53 8
43	42 2	08 2	103	101 1	19 7	163	160 0	31 1	223	218 9	42 6	283	277 0	54 0
44	43 2	08 4	104	102 1	19 8	164	161 0	31 3	224	219 9	42 7	284	278 0	54 2
45	44 2	08 6	105	103 1	20 0	165	162 0	31 5	225	220 9	42 9	285	279 0	54 4
46	45 2	08 8	106	104 1	20 2	166	163 0	31 7	226	221 8	43 1	286	280 0	54 6
47	46 1	09 0	107	105 0	20 4	167	163 9	31 9	227	222 8	43 3	287	281 0	54 8
48	47 1	09 2	108	106 0	20 6	168	164 9	32 1	228	223 8	43 5	288	282 0	55 0
49	48 1	09 3	109	107 0	20 8	169	165 9	32 2	229	224 8	43 7	289	283 0	55 1
50	49 1	09 5	110	108 0	21 0	170	166 9	32 4	230	225 8	43 9	290	284 0	55 3
51	50 1	09 7	111	109 0	21 2	171	167 9	32 6	231	226 8	44 1	291	285 0	55 5
52	51 0	09 9	112	109 9	21 4	172	168 8	32 8	232	227 7	44 3	292	286 0	55 7
53	52 0	10 1	113	110 9	21 6	173	169 8	33 0	233	228 7	44 5	293	287 0	55 9
54	53 0	10 3	114	111 9	21 8	174	170 8	33 2	234	229 7	44 6	294	288 0	56 1
55	54 0	10 5	115	112 9	21 9	175	171 8	33 4	235	230 7	44 8	295	289 0	56 3
56	55 0	10 7	116	113 9	22 1	176	172 8	33 6	236	231 7	45 0	296	290 0	56 5
57	56 0	10 9	117	114 9	22 3	177	173 7	33 8	237	232 6	45 2	297	291 0	56 7
58	56 9	11 1	118	115 8	22 5	178	174 7	34 0	238	233 6	45 4	298	292 0	56 9
59	57 9	11 3	119	116 8	22 7	179	175 7	34 2	239	234 6	45 6	299	293 0	57 1
60	58 9	11 4	120	117 8	22 9	180	176 7	34 3	240	235 5	45 8	300	294 0	57 3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 79 Degrees.

TABLE II.

Difference of Latitude and Departure for 12 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	59 7	12 7	121	118 4	25 2	181	177 0	37 6	241	235 7	50 1
2	02 0	00 4	62	60 6	12 9	122	119 3	25 4	82	178 0	37 8	42	236 7	50 3
3	02 9	00 6	63	61 6	13 1	123	120 3	25 6	83	179 0	38 0	43	237 7	50 5
4	03 9	00 8	64	62 6	13 3	124	121 3	25 8	84	180 0	38 3	44	238 7	50 7
5	04 9	01 0	65	63 6	13 5	125	122 3	26 0	85	181 0	38 5	45	239 6	50 9
6	05 9	01 2	66	64 6	13 7	126	123 3	26 2	86	182 0	38 7	46	240 6	51 1
7	06 8	01 5	67	65 5	13 9	127	124 2	26 4	87	183 0	38 9	47	241 6	51 4
8	07 8	01 7	68	66 5	14 1	128	125 2	26 6	88	184 0	39 1	48	242 6	51 6
9	08 8	01 9	69	67 5	14 3	129	126 2	26 8	89	185 0	39 3	49	243 6	51 8
10	09 8	02 1	70	68 5	14 6	130	127 2	27 0	90	186 0	39 5	50	244 6	52 0
11	10 8	02 3	71	69 4	14 7	131	128 1	27 2	191	186 8	39 7	251	245 5	52 2
12	11 7	02 5	72	70 4	15 0	132	129 1	27 4	92	187 8	39 9	52	246 5	52 4
13	12 7	02 7	73	71 4	15 2	133	130 1	27 7	93	188 8	40 1	53	247 5	52 6
14	13 7	02 9	74	72 4	15 4	134	131 1	27 9	94	189 8	40 3	54	248 4	52 8
15	14 7	03 1	75	73 4	15 6	135	132 0	28 1	95	190 7	40 5	55	249 4	53 0
16	15 7	03 3	76	74 3	15 8	136	133 0	28 3	96	191 7	40 8	56	250 4	53 2
17	16 6	03 5	77	75 3	16 0	137	134 0	28 5	97	192 7	41 0	57	251 4	53 4
18	17 6	03 7	78	76 3	16 2	138	135 0	28 7	98	193 7	41 2	58	252 4	53 6
19	18 6	04 0	79	77 3	16 4	139	136 0	28 9	99	194 7	41 4	59	253 3	53 8
20	19 6	04 2	80	78 3	16 6	140	136 9	29 1	200	195 6	41 6	60	254 3	54 1
21	20 5	04 4	81	79 2	16 8	141	137 9	29 3	201	196 6	41 8	61	255 3	54 3
22	21 5	04 6	82	80 2	17 0	142	138 9	29 5	02	197 6	42 0	62	256 3	54 5
23	22 5	04 8	83	81 2	17 3	143	139 9	29 7	03	198 6	42 2	63	257 3	54 7
24	23 5	05 0	84	82 2	17 5	144	140 9	29 9	04	199 6	42 4	64	258 2	54 9
25	24 5	05 2	85	83 1	17 7	145	141 8	30 1	05	200 5	42 6	65	259 2	55 1
26	25 4	05 4	86	84 1	17 9	146	142 8	30 4	06	201 5	42 8	66	260 2	55 3
27	26 4	05 6	87	85 1	18 1	147	143 8	30 6	07	202 5	43 0	67	261 2	55 5
28	27 4	05 8	88	86 1	18 3	148	144 8	30 8	08	203 5	43 2	68	262 1	55 7
29	28 4	06 0	89	87 1	18 5	149	145 7	31 0	09	204 4	43 5	69	263 1	55 9
30	29 3	06 2	90	88 0	18 7	150	146 7	31 2	10	205 4	43 7	70	264 1	56 1
31	30 3	06 4	91	89 0	18 9	151	147 7	31 4	11	206 4	43 9	71	265 1	56 3
32	31 3	06 7	92	90 0	19 1	152	148 7	31 6	12	207 4	44 1	72	266 1	56 6
33	32 3	06 9	93	91 0	19 3	153	149 7	31 8	13	208 3	44 3	73	267 0	56 8
34	33 3	07 1	94	91 9	19 5	154	150 6	32 0	14	209 3	44 5	74	268 0	57 0
35	34 2	07 3	95	92 9	19 8	155	151 6	32 2	15	210 3	44 7	75	269 0	57 2
36	35 2	07 5	96	93 9	20 0	156	152 6	32 4	16	211 3	44 9	76	270 0	57 4
37	36 2	07 7	97	94 9	20 2	157	153 6	32 6	17	212 3	45 1	77	270 9	57 6
38	37 2	07 9	98	95 9	20 4	158	154 5	32 9	18	213 2	45 3	78	271 9	57 8
39	38 1	08 1	99	96 8	20 6	159	155 5	33 1	19	214 2	45 5	79	272 9	58 0
40	39 1	08 3	100	97 8	20 8	160	156 5	33 3	20	215 2	45 7	80	273 9	58 2
41	40 1	08 5	101	98 8	21 0	161	157 5	33 5	21	216 2	45 9	81	274 9	58 4
42	41 1	08 7	02	99 8	21 2	162	158 5	33 7	22	217 1	46 2	82	275 8	58 6
43	42 1	08 9	03	100 7	21 4	163	159 4	33 9	23	218 1	46 4	83	276 8	58 8
44	43 0	09 1	04	101 7	21 6	164	160 4	34 1	24	219 1	46 6	84	277 8	59 0
45	44 0	09 3	05	102 7	21 8	165	161 4	34 3	25	220 1	46 8	85	278 8	59 3
46	45 0	09 6	06	103 7	22 0	166	162 4	34 5	26	221 1	47 0	86	279 8	59 5
47	46 0	09 8	07	104 7	22 2	167	163 4	34 7	27	222 0	47 2	87	280 7	59 7
48	47 0	10 0	08	105 7	22 5	168	164 3	34 9	28	223 0	47 4	88	281 7	59 9
49	47 9	10 2	09	106 6	22 7	169	165 3	35 1	29	224 0	47 6	89	282 7	60 1
50	48 9	10 4	10	107 6	22 9	170	166 3	35 3	30	225 0	47 8	90	283 7	60 3
51	49 9	10 6	11	108 6	23 1	171	167 3	35 6	31	226 0	48 0	91	284 6	60 5
52	50 9	10 8	12	109 6	23 3	172	168 2	35 8	32	226 9	48 2	92	285 6	60 7
53	51 8	11 0	13	110 5	23 5	173	169 2	36 0	33	227 9	48 4	93	286 6	60 9
54	52 8	11 2	14	111 5	23 7	174	170 2	36 2	34	228 9	48 7	94	287 6	61 1
55	53 8	11 4	15	112 5	23 9	175	171 2	36 4	35	229 9	48 9	95	288 6	61 3
56	54 8	11 6	16	113 5	24 1	176	172 2	36 6	36	230 8	49 1	96	289 5	61 5
57	55 8	11 9	17	114 4	24 3	177	173 1	36 8	37	231 8	49 3	97	290 5	61 7
58	56 7	12 1	18	115 4	24 5	178	174 1	37 0	38	232 8	49 5	98	291 5	62 0
59	57 7	12 3	19	116 4	24 7	179	175 1	37 2	39	233 8	49 7	99	292 5	62 2
60	58 7	12 5	20	117 4	24 9	180	176 1	37 4	40	234 8	49 9	100	293 4	62 4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 78 Degrees.]

TABLE II.

29

Difference of Latitude and Departure for 13 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	59 4	13 7	121	117 9	27 2	181	176 4	40 7	241	234 8	54 2
2	01 9	00 4	62	60 4	13 9	22	118 9	27 4	82	177 3	40 9	42	235 8	54 4
3	02 9	00 7	63	61 4	14 2	23	119 8	27 7	83	178 3	41 2	43	236 8	54 7
4	03 9	00 9	64	62 4	14 4	24	120 8	27 9	84	179 3	41 4	44	237 7	54 9
5	04 9	01 1	65	63 3	14 6	25	121 8	28 1	85	180 3	41 6	45	238 7	55 1
6	05 8	01 3	66	64 3	14 8	26	122 8	28 3	86	181 2	41 8	46	239 7	55 3
7	06 8	01 6	67	65 3	15 1	27	123 7	28 6	87	182 2	42 1	47	240 7	55 6
8	07 8	01 8	68	66 3	15 3	28	124 7	28 8	88	183 2	42 3	48	241 6	55 8
9	08 8	02 0	69	67 2	15 5	29	125 7	29 0	89	184 2	42 5	49	242 6	56 0
10	09 7	02 2	70	68 2	15 7	30	126 7	29 2	90	185 1	42 7	50	243 6	56 2
11	10 7	02 5	71	69 2	16 0	131	127 6	29 5	191	186 1	43 0	251	244 6	56 5
12	11 7	02 7	72	70 2	16 2	32	128 6	29 7	92	187 1	43 2	52	245 5	56 7
13	12 7	02 9	73	71 1	16 4	33	129 6	29 9	93	188 1	43 4	53	246 5	56 9
14	13 6	03 1	74	72 1	16 6	34	130 6	30 1	94	189 0	43 6	54	247 5	57 1
15	14 6	03 4	75	73 1	16 9	35	131 5	30 4	95	190 0	43 9	55	248 5	57 4
16	15 6	03 6	76	74 1	17 1	36	132 5	30 6	96	191 0	44 1	56	249 4	57 6
17	16 6	03 8	77	75 0	17 3	37	133 5	30 8	97	192 0	44 3	57	250 4	57 8
18	17 5	04 0	78	76 0	17 5	38	134 5	31 0	98	192 9	44 5	58	251 4	58 0
19	18 5	04 3	79	77 0	17 8	39	135 4	31 3	99	193 9	44 8	59	252 4	58 3
20	19 5	04 5	80	77 9	18 0	40	136 4	31 5	200	194 9	45 0	60	253 3	58 5
21	20 5	04 7	81	78 9	18 2	141	137 4	31 7	201	195 8	45 2	261	254 3	58 7
22	21 4	04 9	82	79 9	18 4	42	138 4	31 9	02	196 8	45 4	62	255 3	58 9
23	22 4	05 2	83	80 9	18 7	43	139 3	32 2	03	197 8	45 7	63	256 3	59 2
24	23 4	05 4	84	81 8	18 9	44	140 3	32 4	04	198 8	45 9	64	257 2	59 4
25	24 4	05 6	85	82 8	19 1	45	141 3	32 6	05	199 7	46 1	65	258 2	59 6
26	25 3	05 8	86	83 8	19 3	46	142 3	32 8	06	200 7	46 3	66	259 2	59 8
27	26 3	06 1	87	84 8	19 6	47	143 2	33 1	07	201 7	46 6	67	260 2	60 1
28	27 3	06 3	88	85 7	19 8	48	144 2	33 3	08	202 7	46 8	68	261 1	60 3
29	28 3	06 5	89	86 7	20 0	49	145 2	33 5	09	203 6	47 0	69	262 1	60 5
30	29 2	06 7	90	87 7	20 2	50	146 2	33 7	10	204 6	47 2	70	263 1	60 7
31	30 2	07 0	91	88 7	20 5	151	147 1	34 0	211	205 6	47 5	271	264 1	61 0
32	31 2	07 2	92	89 6	20 7	52	148 1	34 2	12	206 6	47 7	72	265 0	61 2
33	32 2	07 4	93	90 6	20 9	53	149 1	34 4	13	207 5	47 9	73	266 0	61 4
34	33 1	07 6	94	91 6	21 1	54	150 1	34 6	14	208 5	48 1	74	267 0	61 6
35	34 1	07 9	95	92 6	21 4	55	151 0	34 9	15	209 5	48 4	75	268 0	61 9
36	35 1	08 1	96	93 5	21 6	56	152 0	35 1	16	210 5	48 6	76	269 9	62 1
37	36 1	08 3	97	94 5	21 8	57	153 0	35 3	17	211 4	48 8	77	269 9	62 3
38	37 0	08 5	98	95 5	22 0	58	154 0	35 5	18	212 4	49 0	78	270 9	62 5
39	38 0	08 8	99	96 5	22 3	59	154 9	35 8	19	213 4	49 3	79	271 8	62 8
40	39 0	09 0	100	97 4	22 5	60	155 9	36 0	20	214 4	49 5	80	272 8	63 0
41	39 9	09 2	101	98 4	22 7	161	156 9	36 2	221	215 3	49 7	281	273 8	63 2
42	40 9	09 4	02	99 4	22 9	62	157 8	36 4	22	216 3	49 9	82	274 8	63 4
43	41 9	09 7	03	100 4	23 2	63	158 8	36 7	23	217 3	50 2	83	275 7	63 7
44	42 9	09 9	04	101 3	23 4	64	159 8	36 9	24	218 3	50 4	84	276 7	63 9
45	43 8	10 1	05	102 3	23 6	65	160 8	37 1	25	219 2	50 6	85	277 7	64 1
46	44 8	10 3	06	103 3	23 8	66	161 7	37 3	26	220 2	50 8	86	278 7	64 3
47	45 8	10 6	07	104 3	24 1	67	162 7	37 6	27	221 2	51 1	87	279 6	64 6
48	46 8	10 8	08	105 2	24 3	68	163 7	37 8	28	222 1	51 3	88	280 6	64 8
49	47 7	11 0	09	106 2	24 5	69	164 7	38 1	29	223 1	51 5	89	281 6	65 0
50	48 7	11 2	10	107 2	24 7	70	165 6	38 3	30	224 1	51 7	90	282 6	65 2
51	49 7	11 5	111	108 2	25 0	171	166 6	38 5	231	225 1	52 0	291	283 5	65 5
52	50 7	11 7	112	109 1	25 2	72	167 6	38 7	32	226 1	52 2	92	284 5	65 7
53	51 6	11 9	113	110 1	25 4	73	168 6	38 9	33	227 0	52 4	93	285 5	65 9
54	52 6	12 1	114	111 1	25 6	74	169 6	39 1	34	228 0	52 6	94	286 5	66 1
55	53 6	12 4	115	112 1	25 9	75	170 5	39 4	35	229 0	52 9	95	287 4	66 4
56	54 6	12 6	116	113 0	26 1	76	171 5	39 6	36	230 0	53 1	96	288 4	66 6
57	55 5	12 8	117	114 0	26 3	77	172 5	39 8	37	230 9	53 3	97	289 4	66 8
58	56 5	13 0	118	115 0	26 5	78	173 4	40 1	38	231 9	53 5	98	290 4	67 0
59	57 5	13 3	119	116 0	26 8	79	174 4	40 3	39	232 9	53 8	99	291 3	67 3
60	58 5	13 5	120	116 9	27 0	80	175 4	40 5	40	233 9	54 0	300	292 3	67 5

[For 77 Degrees.]

TABLE II.

Difference of Latitude and Departure for 14 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 2	61	59 2	14 8	121	117 4	29 3	181	175 6	43 8	241	233 8	58 3
2	01 9	00 5	62	60 2	15 0	122	118 4	29 5	182	176 6	44 0	242	234 8	58 6
3	02 9	01 7	63	61 1	15 2	123	119 3	29 8	183	177 6	44 3	243	235 8	58 9
4	03 9	01 0	64	62 1	15 5	124	120 3	30 0	184	178 8	44 5	244	236 8	59 0
5	04 9	01 2	65	63 1	15 7	125	121 3	30 2	185	179 8	44 8	245	237 7	59 3
6	05 8	01 5	66	64 0	16 0	126	122 3	30 5	186	180 8	45 0	246	238 7	59 6
7	06 8	01 7	67	65 0	16 2	127	123 2	30 7	187	181 4	45 2	247	239 7	59 8
8	07 8	01 9	68	66 0	16 5	128	124 2	31 0	188	182 4	45 5	248	240 6	60 0
9	08 7	02 2	69	67 0	16 7	129	125 2	31 2	189	183 4	45 7	249	241 6	60 2
10	09 7	02 4	70	67 9	16 9	130	126 1	31 4	190	184 4	46 0	250	242 6	60 5
11	10 7	02 7	71	68 9	17 2	131	127 1	31 7	191	185 3	46 2	251	243 5	60 7
12	11 6	02 9	72	69 9	17 4	132	128 1	31 9	192	186 3	46 4	252	244 5	61 0
13	12 6	03 1	73	70 8	17 7	133	129 0	32 2	193	187 3	46 7	253	245 5	61 2
14	13 6	03 4	74	71 8	17 9	134	130 0	32 4	194	188 2	46 9	254	246 5	61 4
15	14 6	03 6	75	72 8	18 1	135	131 0	32 7	195	189 2	47 2	255	247 4	61 7
16	15 5	03 9	76	73 7	18 4	136	132 0	32 9	196	190 2	47 4	256	248 4	61 9
17	16 5	04 1	77	74 7	18 6	137	132 9	33 1	197	191 1	47 7	257	249 4	62 2
18	17 5	04 4	78	75 7	18 9	138	133 9	33 4	198	192 1	47 9	258	250 3	62 4
19	18 4	04 6	79	76 7	19 1	139	134 9	33 6	199	193 1	48 1	259	251 3	62 7
20	19 4	04 8	80	77 6	19 4	140	135 8	33 9	200	194 1	48 4	260	252 3	62 9
21	20 4	05 1	81	78 6	19 6	141	136 8	34 1	201	196 0	48 6	261	253 2	63 1
22	21 3	05 3	82	79 6	19 8	142	137 8	34 4	202	196 0	48 9	262	254 2	63 4
23	22 3	05 6	83	80 5	20 1	143	138 8	34 6	203	197 0	49 1	263	255 2	63 6
24	23 3	05 8	84	81 5	20 3	144	139 7	34 8	204	197 9	49 4	264	256 2	63 9
25	24 3	06 0	85	82 5	20 6	145	140 7	35 1	205	198 9	49 6	265	257 1	64 1
26	25 2	06 3	86	83 4	20 8	146	141 7	35 3	206	199 9	49 8	266	258 1	64 4
27	26 2	06 5	87	84 4	21 0	147	142 6	35 6	207	200 9	50 1	267	259 1	64 6
28	27 2	06 8	88	85 4	21 3	148	143 6	35 8	208	201 8	50 3	268	260 0	64 8
29	28 1	07 0	89	86 4	21 5	149	144 6	36 0	209	202 8	50 6	269	261 0	65 1
30	29 1	07 3	90	87 3	21 8	150	145 5	36 3	210	203 8	50 8	270	262 0	65 3
31	30 1	07 5	91	88 3	22 0	151	146 5	36 5	211	204 7	51 0	271	263 0	65 6
32	31 0	07 7	92	89 3	22 3	152	147 5	36 8	212	205 7	51 3	272	263 9	65 8
33	32 0	08 0	93	90 2	22 6	153	148 5	37 0	213	206 7	51 5	273	264 9	66 0
34	33 0	08 2	94	91 2	22 7	154	149 4	37 3	214	207 6	51 8	274	265 9	66 3
35	34 0	08 5	95	92 2	23 0	155	150 4	37 5	215	208 6	52 0	275	266 8	66 5
36	34 9	08 7	96	93 1	23 2	156	151 4	37 7	216	209 6	52 3	276	267 8	66 8
37	35 9	09 0	97	94 1	23 5	157	152 3	38 0	217	210 6	52 5	277	268 8	67 0
38	36 9	09 2	98	95 1	23 7	158	153 3	38 2	218	211 5	52 7	278	269 7	67 3
39	37 8	09 4	99	96 1	24 0	159	154 3	38 5	219	212 5	53 0	279	270 7	67 5
40	38 8	09 7	100	97 0	24 2	160	155 2	38 7	220	213 5	53 2	280	271 7	67 7
41	39 8	09 9	101	98 0	24 4	161	156 2	38 9	221	214 4	53 5	281	272 7	68 0
42	40 8	10 2	102	99 0	24 7	162	157 2	39 2	222	215 4	53 7	282	273 6	68 2
43	41 7	10 4	103	99 9	24 9	163	158 2	39 4	223	216 4	53 9	283	274 6	68 5
44	42 7	10 6	104	100 9	25 2	164	159 1	39 7	224	217 3	54 2	284	275 6	68 7
45	43 7	10 9	105	101 9	25 4	165	160 1	39 9	225	218 3	54 4	285	276 5	69 0
46	44 6	11 1	106	102 9	25 6	166	161 1	40 2	226	219 3	54 7	286	277 5	69 2
47	45 6	11 4	107	103 8	25 9	167	162 0	40 4	227	220 3	54 9	287	278 5	69 4
48	46 6	11 6	108	104 8	26 1	168	163 0	40 6	228	221 2	55 2	288	279 4	69 7
49	47 5	11 9	109	105 8	26 4	169	164 0	40 9	229	222 2	55 4	289	280 4	69 9
50	48 5	12 1	110	106 7	26 6	170	165 0	41 1	230	223 2	55 6	290	281 4	70 2
51	49 5	12 3	111	107 7	26 9	171	165 9	41 4	231	224 1	55 9	291	282 4	70 4
52	50 5	12 6	112	108 7	27 1	172	166 9	41 6	232	225 1	56 1	292	283 3	70 6
53	51 4	12 8	113	109 6	27 3	173	167 9	41 9	233	226 1	56 4	293	284 3	70 9
54	52 4	13 1	114	110 6	27 6	174	168 8	42 1	234	227 0	56 6	294	285 3	71 1
55	53 4	13 3	115	111 6	27 8	175	169 8	42 3	235	228 0	56 9	295	286 2	71 4
56	54 3	13 5	116	112 6	28 1	176	170 8	42 6	236	229 0	57 1	296	287 2	71 6
57	55 3	13 8	117	113 5	28 3	177	171 7	42 8	237	230 0	57 3	297	288 2	71 9
58	56 3	14 0	118	114 5	28 5	178	172 7	43 1	238	230 9	57 6	298	289 1	72 1
59	57 2	14 2	119	115 5	28 8	179	173 7	43 3	239	231 9	57 8	299	290 1	72 3
60	58 2	14 4	120	116 4	29 0	180	174 7	43 5	240	232 9	58 1	300	291 1	72 6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 76 Degrees.]

TABLE II.

31

Difference of Latitude and Departure for 15 Degrees.

Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
00.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
00.6	62	59.9	16.0	22	117.8	31.6	82	175.8	47.1	42	233.8	62.6
00.8	63	60.9	16.3	23	118.8	31.8	83	176.8	47.4	43	234.7	62.9
01.0	64	61.8	16.6	24	119.8	32.1	84	177.7	47.6	44	235.7	63.2
01.3	65	62.8	16.8	25	120.7	32.4	85	178.7	47.9	45	236.7	63.4
01.6	66	63.8	17.1	26	121.7	32.6	86	179.7	48.1	46	237.6	63.7
01.8	67	64.7	17.3	27	122.7	32.9	87	180.6	48.4	47	238.6	63.9
02.1	68	65.7	17.6	28	123.6	33.1	88	181.6	48.7	48	239.5	64.2
02.3	69	66.6	17.9	29	124.6	33.4	89	182.6	48.9	49	240.5	64.4
02.6	70	67.6	18.1	30	125.6	33.6	90	183.5	49.2	50	241.5	64.7
02.8	71	68.6	18.4	31	126.6	33.9	91	184.5	49.4	51	242.4	65.0
03.1	72	69.5	18.6	32	127.5	34.2	92	185.5	49.7	52	243.4	65.2
03.4	73	70.5	18.9	33	128.5	34.4	93	186.4	50.0	53	244.4	65.5
03.6	74	71.5	19.2	34	129.4	34.7	94	187.4	50.2	54	245.3	65.7
03.9	75	72.4	19.4	35	130.4	34.9	95	188.4	50.5	55	246.3	66.0
04.1	76	73.4	19.7	36	131.4	35.2	96	189.3	50.7	56	247.3	66.3
04.4	77	74.4	19.9	37	132.3	35.5	97	190.3	51.0	57	248.2	66.6
04.7	78	75.3	20.2	38	133.3	35.7	98	191.3	51.2	58	249.2	66.8
04.9	79	76.3	20.4	39	134.3	36.0	99	192.2	51.5	59	250.2	67.0
05.2	80	77.3	20.7	40	135.2	36.2	100	193.2	51.8	60	251.1	67.3
05.4	81	78.2	21.0	41	136.2	36.5	101	194.2	52.0	61	252.1	67.6
05.7	82	79.2	21.2	42	137.2	36.8	102	195.1	52.3	62	253.1	67.8
06.0	83	80.2	21.5	43	138.1	37.0	103	196.1	52.5	63	254.0	68.1
06.2	84	81.1	21.7	44	139.1	37.3	104	197.0	52.8	64	255.0	68.4
06.5	85	82.1	22.0	45	140.1	37.5	105	198.0	53.1	65	256.0	68.6
06.7	86	83.1	22.3	46	141.0	37.8	106	199.0	53.3	66	256.9	68.8
07.0	87	84.0	22.5	47	142.0	38.0	107	199.9	53.6	67	257.9	69.1
07.2	88	85.0	22.8	48	143.0	38.3	108	200.9	53.8	68	258.8	69.4
07.5	89	86.0	23.0	49	143.9	38.6	109	201.9	54.1	69	259.8	69.6
07.8	90	86.9	23.3	50	144.9	38.8	110	202.8	54.4	70	260.8	69.9
08.0	91	87.9	23.6	51	145.9	39.1	111	203.8	54.6	71	261.8	70.1
08.3	92	88.9	23.8	52	146.8	39.3	112	204.8	54.9	72	262.7	70.4
08.5	93	89.8	24.1	53	147.8	39.6	113	205.7	55.1	73	263.7	70.7
08.8	94	90.8	24.3	54	148.8	39.9	114	206.7	55.4	74	264.7	71.0
09.1	95	91.8	24.6	55	149.7	40.1	115	207.7	55.6	75	265.6	71.2
09.3	96	92.7	24.8	56	150.7	40.4	116	208.6	55.9	76	266.6	71.5
09.6	97	93.7	25.1	57	151.7	40.6	117	209.6	56.2	77	267.6	71.8
09.8	98	94.7	25.4	58	152.6	40.9	118	210.6	56.4	78	268.5	72.0
10.1	99	95.6	25.6	59	153.6	41.2	119	211.5	56.7	79	269.5	72.2
10.4	100	96.6	25.9	60	154.5	41.4	120	212.5	56.9	80	270.5	72.5
10.6	101	97.6	26.1	61	155.5	41.7	121	213.5	57.2	81	271.4	72.7
10.9	102	98.5	26.4	62	156.5	41.9	122	214.5	57.5	82	272.4	73.0
11.1	103	99.5	26.7	63	157.4	42.2	123	215.4	57.7	83	273.4	73.2
11.4	104	100.5	26.9	64	158.4	42.4	124	216.4	58.0	84	274.3	73.5
11.6	105	101.4	27.2	65	159.4	42.7	125	217.3	58.2	85	275.3	73.8
11.9	106	102.4	27.4	66	160.3	43.0	126	218.3	58.5	86	276.3	74.1
12.2	107	103.4	27.7	67	161.3	43.2	127	219.3	58.8	87	277.2	74.4
12.4	108	104.3	28.0	68	162.3	43.5	128	220.2	59.0	88	278.2	74.7
12.7	109	105.3	28.2	69	163.2	43.7	129	221.2	59.3	89	279.2	75.0
12.9	110	106.3	28.5	70	164.2	44.0	130	222.2	59.5	90	280.1	75.1
13.2	111	107.2	28.7	71	165.2	44.3	131	223.1	59.8	91	281.1	75.3
13.5	112	108.2	29.0	72	166.1	44.5	132	224.1	60.0	92	282.1	75.6
13.7	113	109.1	29.2	73	167.1	44.8	133	225.1	60.3	93	283.0	75.8
14.0	114	110.1	29.5	74	168.1	45.0	134	226.0	60.6	94	284.0	76.1
14.2	115	111.1	29.8	75	169.0	45.3	135	227.0	60.8	95	284.9	76.4
14.5	116	112.0	30.0	76	170.0	45.6	136	228.0	61.1	96	285.9	76.6
14.8	117	113.0	30.3	77	171.0	45.8	137	228.9	61.3	97	286.9	76.9
15.0	118	114.0	30.5	78	171.9	46.1	138	229.9	61.6	98	287.8	77.1
15.3	119	114.9	30.8	79	172.9	46.3	139	230.9	61.9	99	288.8	77.4
15.5	120	115.9	31.1	80	173.9	46.6	140	231.8	62.1	100	289.8	77.6
Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 76 Degrees.]

TABLE II.

Difference of Latitude and Departure for 16 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.6	16.8	121	116.3	33.4	181	174.0	49.9	241	231.7	66.4
2	01.9	00.6	62	59.6	17.1	22	117.3	33.6	82	174.9	50.2	42	232.6	66.7
3	02.9	00.8	63	60.6	17.4	23	118.2	33.9	83	175.9	50.4	43	233.6	67.0
4	03.8	01.1	64	61.5	17.6	24	119.2	34.2	84	176.9	50.7	44	234.5	67.3
5	04.8	01.4	65	62.5	17.9	25	120.2	34.5	85	177.8	51.0	45	235.5	67.5
6	05.8	01.7	66	63.4	18.2	26	121.1	34.7	86	178.8	51.3	46	236.5	67.8
7	06.7	01.9	67	64.4	18.5	27	122.1	35.0	87	179.8	51.5	47	237.4	68.1
8	07.7	02.2	68	65.4	18.7	28	123.0	35.3	88	180.7	51.8	48	238.4	68.4
9	08.7	02.5	69	66.3	19.0	29	124.0	35.6	89	181.7	52.1	49	239.4	68.6
10	09.6	02.8	70	67.3	19.3	30	125.0	35.8	90	182.6	52.4	50	240.3	68.9
11	10.6	03.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.3	69.2
12	11.5	03.3	72	69.2	19.8	32	126.9	36.4	92	184.6	52.9	52	242.2	69.5
13	12.5	03.6	73	70.2	20.1	33	127.8	36.7	93	185.5	53.2	53	243.2	69.7
14	13.5	03.9	74	71.1	20.4	34	128.8	36.9	94	186.5	53.5	54	244.2	70.0
15	14.4	04.1	75	72.1	20.7	35	129.8	37.2	95	187.4	53.7	55	245.1	70.3
16	15.4	04.4	76	73.1	20.9	36	130.7	37.5	96	188.4	54.0	56	246.1	70.6
17	16.3	04.7	77	74.0	21.2	37	131.7	37.8	97	189.4	54.3	57	247.0	70.8
18	17.3	05.0	78	75.0	21.5	38	132.7	38.0	98	190.3	54.6	58	248.0	71.1
19	18.3	05.2	79	75.9	21.8	39	133.6	38.3	99	191.3	54.9	59	249.0	71.4
20	19.2	05.5	80	76.9	22.1	40	134.6	38.6	200	192.3	55.1	60	249.9	71.7
21	20.2	05.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	06.1	82	78.8	22.6	42	136.5	39.1	02	194.2	55.7	62	251.9	72.2
23	22.1	06.3	83	79.8	22.9	43	137.5	39.4	03	195.1	56.0	63	252.8	72.5
24	23.1	06.6	84	80.7	23.2	44	138.4	39.7	04	196.1	56.2	64	253.8	72.8
25	24.0	06.9	85	81.7	23.4	45	139.4	40.0	05	197.1	56.5	65	254.7	73.0
26	25.0	07.2	86	82.7	23.7	46	140.3	40.2	06	198.0	56.8	66	255.7	73.3
27	26.0	07.4	87	83.6	24.0	47	141.3	40.5	07	199.0	57.1	67	256.7	73.6
28	26.9	07.7	88	84.6	24.3	48	142.3	40.8	08	199.9	57.3	68	257.6	73.9
29	27.9	08.0	89	85.6	24.5	49	143.2	41.1	09	200.9	57.6	69	258.6	74.1
30	28.8	08.3	90	86.5	24.8	50	144.2	41.3	10	201.9	57.9	70	259.5	74.4
31	29.8	08.5	91	87.5	25.1	151	145.2	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	08.8	92	88.4	25.4	52	146.1	41.9	12	203.8	58.4	72	261.5	75.0
33	31.7	09.1	93	89.4	25.6	53	147.1	42.2	13	204.7	58.7	73	262.4	75.2
34	32.7	09.4	94	90.4	25.9	54	148.0	42.4	14	205.7	59.0	74	263.4	75.5
35	33.6	09.6	95	91.3	26.2	55	149.0	42.7	15	206.7	59.3	75	264.3	75.8
36	34.6	09.9	96	92.3	26.5	56	150.0	43.0	16	207.6	59.5	76	265.3	76.1
37	35.6	10.2	97	93.2	26.7	57	150.9	43.3	17	208.6	59.8	77	266.3	76.4
38	36.5	10.5	98	94.2	27.0	58	151.9	43.6	18	209.6	60.1	78	267.2	76.6
39	37.5	10.7	99	95.2	27.3	59	152.8	43.8	19	210.5	60.4	79	268.2	76.9
40	38.5	11.0	100	96.1	27.6	60	153.8	44.1	20	211.5	60.6	80	269.2	77.2
41	39.4	11.3	101	97.1	27.8	161	154.8	44.4	221	212.4	60.9	281	270.1	77.5
42	40.4	11.6	02	98.0	28.1	62	155.7	44.7	22	213.4	61.2	82	271.1	77.7
43	41.3	11.9	03	99.0	28.4	63	156.7	44.9	23	214.4	61.5	83	272.0	78.0
44	42.3	12.1	04	100.0	28.7	64	157.6	45.2	24	215.3	61.7	84	273.0	78.3
45	43.3	12.4	05	100.9	28.9	65	158.6	45.5	25	216.3	62.0	85	274.0	78.6
46	44.2	12.7	06	101.9	29.2	66	159.6	45.8	26	217.2	62.3	86	274.9	78.8
47	45.2	13.0	07	102.9	29.5	67	160.5	46.0	27	218.2	62.6	87	275.9	79.1
48	46.1	13.2	08	103.8	29.8	68	161.5	46.3	28	219.2	62.8	88	276.8	79.4
49	47.1	13.5	09	104.8	30.0	69	162.5	46.6	29	220.1	63.1	89	277.8	79.7
50	48.1	13.8	10	105.7	30.3	70	163.4	46.9	30	221.1	63.4	90	278.8	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.1	63.7	291	279.7	80.
52	50.0	14.3	12	107.7	30.9	72	165.3	47.4	32	223.0	63.9	92	280.7	80.
53	50.9	14.6	13	108.6	31.1	73	166.3	47.7	33	224.0	64.2	93	281.6	80
54	51.9	14.9	14	109.6	31.4	74	167.3	48.0	34	224.9	64.5	94	282.6	81
55	52.9	15.2	15	110.5	31.7	75	168.2	48.2	35	225.9	64.8	95	283.6	81
56	53.8	15.4	16	111.5	32.0	76	169.2	48.5	36	226.9	65.1	96	284.5	8
57	54.8	15.7	17	112.5	32.2	77	170.1	48.8	37	227.8	65.3	97	285.5	8
58	55.8	16.0	18	113.4	32.5	78	171.1	49.1	38	228.8	65.6	98	286.5	8
59	56.7	16.3	19	114.4	32.8	79	172.1	49.3	39	229.7	65.9	99	287.4	1
60	57.7	16.5	20	115.4	33.1	80	173.0	49.6	40	230.7	66.2	300	288.4	
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 74 D

TABLE II.

33

Difference of Latitude and Departure for 17 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01 0	00 3	61	63 3	17 8	121	115 7	35 4	181	173 1	52 9	241	230 5	70 3
2	01 9	00 6	62	63 9	18 1	122	116 7	35 7	182	174 0	53 2	242	231 4	70 8
3	02 9	00 9	63	60 2	18 4	123	117 6	36 0	183	175 0	53 5	243	232 4	71 0
4	03 8	01 2	64	61 2	18 7	124	118 5	36 3	184	176 0	53 8	244	233 3	71 3
5	04 8	01 5	65	62 2	19 0	125	119 5	36 5	185	176 9	54 1	245	234 3	71 6
6	05 7	01 8	66	63 1	19 3	126	120 5	36 8	186	177 9	54 4	246	235 3	71 9
7	06 7	02 0	67	64 1	19 6	127	121 5	37 1	187	178 8	54 7	247	236 3	72 2
8	07 7	02 3	68	65 0	19 9	128	122 4	37 4	188	179 8	55 0	248	237 2	72 5
9	08 6	02 6	69	66 0	20 2	129	123 4	37 7	189	180 7	55 3	249	238 1	72 8
10	09 6	02 9	70	66 9	20 5	130	124 3	38 0	190	181 7	55 6	250	239 1	73 1
11	10 5	03 2	71	67 9	20 8	131	125 3	38 3	191	182 7	55 8	251	240 0	73 4
12	11 5	03 5	72	68 9	21 1	132	126 2	38 6	192	183 6	56 1	252	241 0	73 7
13	12 4	03 8	73	69 8	21 3	133	127 2	38 9	193	184 6	56 4	253	241 9	74 0
14	13 4	04 1	74	70 8	21 6	134	128 1	39 2	194	185 5	56 7	254	242 9	74 3
15	14 3	04 4	75	71 7	21 9	135	129 1	39 5	195	186 5	57 0	255	243 9	74 6
16	15 3	04 7	76	72 7	22 2	136	130 1	39 8	196	187 4	57 3	256	244 8	74 9
17	16 3	05 0	77	73 6	22 5	137	131 0	40 1	197	188 4	57 6	257	245 8	75 1
18	17 2	05 3	78	74 6	22 8	138	132 0	40 3	198	189 3	57 9	258	246 7	75 4
19	18 2	05 6	79	75 5	23 1	139	133 9	40 6	199	190 3	58 2	259	247 7	75 7
20	19 1	05 8	80	76 5	23 4	140	135 9	40 9	200	191 3	58 5	260	248 6	76 0
21	20 1	06 1	81	77 5	23 7	141	136 8	41 2	201	192 2	58 8	261	249 6	76 3
22	21 0	06 4	82	78 4	24 0	142	137 8	41 5	202	193 2	59 1	262	250 6	76 6
23	22 0	06 7	83	79 4	24 3	143	138 8	41 8	203	194 1	59 4	263	251 5	76 9
24	23 0	07 0	84	80 3	24 6	144	139 7	42 1	204	195 1	59 6	264	252 5	77 2
25	23 9	07 3	85	81 3	24 9	145	140 7	42 4	205	196 0	59 9	265	253 4	77 5
26	24 9	07 6	86	82 3	25 1	146	141 6	42 7	206	197 0	60 2	266	254 4	77 8
27	25 8	07 9	87	83 2	25 4	147	142 6	43 0	207	198 0	60 5	267	255 3	78 1
28	26 8	08 2	88	84 2	25 7	148	143 5	43 3	208	199 0	60 8	268	256 3	78 4
29	27 7	08 5	89	85 1	26 0	149	144 5	43 6	209	200 0	61 1	269	257 2	78 6
30	28 7	08 8	90	86 1	26 3	150	145 4	43 9	210	201 0	61 4	270	258 2	78 9
31	29 6	09 1	91	87 0	26 6	151	146 4	44 1	211	201 9	61 7	271	259 2	79 2
32	30 6	09 4	92	88 0	26 9	152	147 4	44 4	212	202 9	62 0	272	260 1	79 5
33	31 6	09 6	93	88 9	27 2	153	148 3	44 7	213	203 9	62 3	273	261 1	79 8
34	32 5	09 9	94	89 9	27 5	154	149 3	45 0	214	204 9	62 6	274	262 0	80 1
35	33 5	10 2	95	90 8	27 8	155	150 2	45 3	215	205 9	62 9	275	263 0	80 4
36	34 4	10 5	96	91 8	28 1	156	151 2	45 6	216	206 9	63 2	276	263 9	80 7
37	35 4	10 8	97	92 7	28 4	157	152 1	45 9	217	207 9	63 4	277	264 9	81 0
38	36 3	11 1	98	93 7	28 7	158	153 1	46 2	218	208 9	63 7	278	265 9	81 3
39	37 3	11 4	99	94 7	29 0	159	154 1	46 5	219	209 9	64 0	279	266 8	81 6
40	38 2	11 7	100	95 6	29 3	160	155 0	46 8	220	210 9	64 3	280	267 8	81 9
41	39 2	12 0	101	96 6	29 6	161	156 0	47 1	221	211 9	64 6	281	268 7	82 2
42	40 2	12 3	102	97 5	29 8	162	156 9	47 4	222	212 9	64 9	282	269 7	82 4
43	41 1	12 6	103	98 5	30 1	163	157 9	47 7	223	213 9	65 2	283	270 6	82 7
44	42 1	12 9	104	99 5	30 4	164	158 8	48 0	224	214 9	65 5	284	271 6	83 0
45	43 0	13 2	105	100 4	30 7	165	159 8	48 3	225	215 9	65 8	285	272 5	83 3
46	44 0	13 5	106	101 4	31 0	166	160 7	48 6	226	216 9	66 1	286	273 5	83 6
47	44 9	13 7	107	102 3	31 3	167	161 7	48 9	227	217 9	66 4	287	274 5	83 9
48	45 9	14 0	108	103 3	31 6	168	162 7	49 1	228	218 9	66 7	288	275 4	84 2
49	46 9	14 3	109	104 2	31 9	169	163 6	49 4	229	219 9	67 0	289	276 4	84 5
50	47 8	14 6	110	105 2	32 2	170	164 6	49 7	230	220 9	67 3	290	277 3	84 8
51	48 8	14 9	111	106 1	32 5	171	165 5	50 0	231	220 9	67 6	291	278 3	85 1
52	49 7	15 2	112	107 1	32 7	172	166 5	50 3	232	221 9	67 8	292	279 2	85 4
53	50 7	15 5	113	108 1	33 0	173	167 4	50 6	233	222 8	68 1	293	280 2	85 7
54	51 6	15 8	114	109 0	33 3	174	168 4	50 9	234	223 8	68 4	294	281 2	86 0
55	52 6	16 1	115	110 0	33 6	175	169 4	51 2	235	224 7	68 7	295	282 1	86 2
56	53 6	16 4	116	110 9	33 9	176	170 3	51 5	236	225 7	69 0	296	283 1	86 5
57	54 5	16 7	117	111 9	34 2	177	171 3	51 7	237	226 6	69 3	297	284 0	86 8
58	55 5	17 0	118	112 8	34 5	178	172 2	52 0	238	227 6	69 6	298	285 0	87 1
59	56 4	17 3	119	113 8	34 8	179	173 2	52 3	239	228 6	69 9	299	285 9	87 4
60	57 4	17 6	120	114 8	35 1	180	174 1	52 6	240	229 5	70 2	300	286 9	87 7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 73 Degrees.]

Difference of Latitude and Departure for 18 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.0	18.9	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	01.9	00.6	62	59.0	19.2	22	116.0	37.7	82	173.1	56.2	42	230.2	74.8
3	02.9	00.9	63	59.9	19.5	23	117.0	38.0	83	174.0	56.6	43	231.1	75.1
4	03.8	01.2	64	60.9	19.8	24	117.9	38.3	84	175.0	56.9	44	232.1	75.4
5	04.8	01.5	65	61.8	20.1	25	118.9	38.6	85	175.9	57.2	45	233.0	75.7
6	05.7	01.9	66	62.8	20.4	26	119.8	38.9	86	176.9	57.5	46	234.0	76.0
7	06.7	02.2	67	63.7	20.7	27	120.8	39.2	87	177.8	57.8	47	234.9	76.3
8	07.6	02.5	68	64.7	21.0	28	121.7	39.6	88	178.8	58.1	48	235.9	76.6
9	08.6	02.8	69	65.6	21.3	29	122.7	39.9	89	179.7	58.4	49	236.8	76.9
10	09.5	03.1	70	66.6	21.6	30	123.6	40.2	90	180.7	58.7	50	237.8	77.3
11	10.5	03.4	71	67.5	21.9	131	124.6	40.5	191	181.7	59.0	251	238.7	77.6
12	11.4	03.7	72	68.5	22.2	32	125.5	40.8	92	182.6	59.3	52	239.7	77.9
13	12.4	04.0	73	69.4	22.6	33	126.5	41.1	93	183.6	59.6	53	240.6	78.2
14	13.3	04.3	74	70.4	22.9	34	127.4	41.4	94	184.5	59.9	54	241.6	78.5
15	14.3	04.6	75	71.3	23.2	35	128.4	41.7	95	185.5	60.3	55	242.5	78.8
16	15.2	04.9	76	72.3	23.5	36	129.3	42.0	96	186.4	60.6	56	243.5	79.1
17	16.2	05.3	77	73.2	23.8	37	130.3	42.3	97	187.4	60.9	57	244.4	79.4
18	17.1	05.6	78	74.2	24.1	38	131.2	42.6	98	188.3	61.2	58	245.4	79.7
19	18.1	05.9	79	75.1	24.4	39	132.2	43.0	99	189.3	61.5	59	246.3	80.0
20	19.0	06.2	80	76.1	24.7	40	133.1	43.3	200	190.2	61.8	60	247.3	80.3
21	20.0	06.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.7
22	20.9	06.8	82	78.0	25.3	42	135.1	43.9	02	192.1	62.4	62	249.2	81.0
23	21.9	07.1	83	78.9	25.6	43	136.0	44.2	03	193.1	62.7	63	250.1	81.3
24	22.8	07.4	84	79.9	26.0	44	137.0	44.5	04	194.0	63.0	64	251.1	81.6
25	23.8	07.7	85	80.8	26.3	45	137.9	44.8	05	195.0	63.3	65	252.0	81.9
26	24.7	08.0	86	81.8	26.6	46	138.9	45.1	06	195.9	63.7	66	253.0	82.2
27	25.7	08.3	87	82.7	26.9	47	139.8	45.4	07	196.9	64.0	67	253.9	82.5
28	26.6	08.7	88	83.7	27.2	48	140.8	45.7	08	197.8	64.3	68	254.9	82.8
29	27.6	09.0	89	84.6	27.5	49	141.7	46.0	09	198.8	64.6	69	255.8	83.1
30	28.5	09.3	90	85.6	27.8	50	142.7	46.4	10	199.7	64.9	70	256.8	83.4
31	29.5	09.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	09.9	92	87.5	28.4	52	144.6	47.0	12	201.6	65.5	72	258.7	84.1
33	31.4	10.2	93	88.4	28.7	53	145.5	47.3	13	202.6	65.8	73	259.6	84.4
34	32.3	10.5	94	89.4	29.0	54	146.5	47.6	14	203.5	66.1	74	260.6	84.7
35	33.3	10.8	95	90.4	29.4	55	147.4	47.9	15	204.5	66.4	75	261.5	85.0
36	34.2	11.1	96	91.3	29.7	56	148.4	48.2	16	205.4	66.7	76	262.5	85.3
37	35.2	11.4	97	92.3	30.0	57	149.3	48.5	17	206.4	67.1	77	263.4	85.6
38	36.1	11.7	98	93.2	30.3	58	150.3	48.9	18	207.3	67.4	78	264.4	85.9
39	37.1	12.1	99	94.2	30.6	59	151.2	49.1	19	208.3	67.7	79	265.3	86.2
40	38.0	12.4	100	95.1	30.9	60	152.2	49.4	20	209.2	68.0	80	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.8	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	02	97.0	31.5	62	154.1	50.1	22	211.1	68.6	82	268.2	87.1
43	40.9	13.3	03	98.0	31.8	63	155.0	50.4	23	212.1	68.9	83	269.1	87.5
44	41.8	13.6	04	98.9	32.1	64	156.0	50.7	24	213.0	69.2	84	270.1	87.8
45	42.8	13.9	05	99.9	32.4	65	156.9	51.0	25	214.0	69.5	85	271.1	88.1
46	43.7	14.2	06	100.8	32.8	66	157.9	51.3	26	214.9	69.8	86	272.0	88.4
47	44.7	14.5	07	101.8	33.1	67	158.8	51.6	27	215.9	70.1	87	273.0	88.7
48	45.7	14.8	08	102.7	33.4	68	159.8	51.9	28	216.8	70.5	88	273.9	89.0
49	46.6	15.1	09	103.7	33.7	69	160.7	52.2	29	217.8	70.8	89	274.9	89.3
50	47.6	15.5	10	104.6	34.0	70	161.7	52.5	30	218.7	71.1	90	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.8	89.9
52	49.5	16.1	12	106.5	34.6	72	163.6	53.2	32	220.6	71.7	92	277.7	90.2
53	50.4	16.4	13	107.5	34.9	73	164.5	53.5	33	221.6	72.0	93	278.7	90.5
54	51.4	16.7	14	108.4	35.2	74	165.5	53.8	34	222.5	72.3	94	279.6	90.9
55	52.3	17.0	15	109.4	35.5	75	166.4	54.1	35	223.5	72.6	95	280.6	91.2
56	53.3	17.3	16	110.3	35.8	76	167.4	54.4	36	224.4	72.9	96	281.5	91.5
57	54.2	17.6	17	111.3	36.2	77	168.3	54.7	37	225.4	73.2	97	282.5	91.8
58	55.2	17.9	18	112.2	36.5	78	169.3	55.0	38	226.4	73.5	98	283.4	92.1
59	56.1	18.2	19	113.2	36.8	79	170.2	55.3	39	227.3	73.9	99	284.4	92.4
60	57.1	18.5	20	114.1	37.1	80	171.2	55.6	40	228.3	74.2	300	285.3	92.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 72 Degrees.]

TABLE II.

Difference of Latitude and Departure for 19 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	01.9	00.7	62	58.6	20.2	22	115.4	39.7	82	172.1	59.3	222	228.8	78.8
3	02.8	01.0	63	59.6	20.5	23	116.3	40.0	83	173.0	59.6	223	229.8	79.1
4	03.8	01.3	64	60.5	20.8	24	117.2	40.4	84	174.0	59.9	224	230.7	79.4
5	04.7	01.6	65	61.5	21.2	25	118.2	40.7	85	174.9	60.2	225	231.7	79.8
6	05.7	02.0	66	62.4	21.5	26	119.1	41.0	86	175.9	60.6	226	232.6	80.1
7	06.6	02.3	67	63.3	21.8	27	120.1	41.3	87	176.8	60.9	227	233.5	80.4
8	07.6	02.6	68	64.3	22.1	28	121.0	41.7	88	177.8	61.2	228	234.5	80.7
9	08.5	02.9	69	65.2	22.5	29	122.0	42.0	89	178.7	61.5	229	235.4	81.1
10	09.5	03.3	70	66.2	22.8	30	122.9	42.3	90	179.6	61.9	230	236.4	81.4
11	10.4	03.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	03.9	72	68.1	23.4	32	124.8	43.0	92	181.5	62.5	252	238.3	82.0
13	12.3	04.2	73	69.0	23.8	33	125.8	43.3	93	182.5	62.8	253	239.2	82.4
14	13.2	04.6	74	70.0	24.1	34	126.7	43.6	94	183.4	63.2	254	240.2	82.7
15	14.2	04.9	75	70.9	24.4	35	127.6	44.0	95	184.4	63.5	255	241.1	83.0
16	15.1	05.2	76	71.9	24.7	36	128.6	44.3	96	185.3	63.8	256	242.1	83.3
17	16.1	05.5	77	72.8	25.1	37	129.5	44.6	97	186.3	64.1	257	243.0	83.7
18	17.0	05.9	78	73.8	25.4	38	130.5	44.9	98	187.2	64.5	258	243.9	84.0
19	18.0	06.2	79	74.7	25.7	39	131.4	45.3	99	188.2	64.8	259	244.9	84.3
20	18.9	06.5	80	75.6	26.0	40	132.4	45.6	200	189.1	65.1	260	245.8	84.6
21	19.9	06.8	81	76.6	26.4	111	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	07.2	82	77.5	26.7	42	134.3	46.2	02	191.0	65.8	262	247.7	85.3
23	21.7	07.5	83	78.5	27.0	43	135.2	46.6	03	191.9	66.1	263	248.7	85.6
24	22.7	07.8	84	79.4	27.3	44	136.2	46.9	04	192.9	66.4	264	249.6	86.0
25	23.6	08.1	85	80.4	27.7	45	137.1	47.2	05	193.8	66.7	265	250.6	86.3
26	24.6	08.5	86	81.3	28.0	46	138.0	47.5	06	194.8	67.1	266	251.5	86.6
27	25.5	08.8	87	82.3	28.3	47	139.0	47.9	07	195.7	67.4	267	252.5	86.9
28	26.5	09.1	88	83.2	28.7	48	139.9	48.2	08	196.7	67.7	268	253.4	87.3
29	27.4	09.4	89	84.2	29.0	49	140.9	48.5	09	197.6	68.0	269	254.3	87.6
30	28.4	09.8	90	85.1	29.3	50	141.8	48.8	10	198.6	68.4	270	255.3	87.9
31	29.3	10.1	91	86.0	29.6	111	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	52	143.7	49.5	12	200.4	69.0	272	257.2	88.5
33	31.2	10.7	93	87.9	30.3	53	144.7	49.8	13	201.4	69.3	273	258.1	88.9
34	32.1	11.1	94	88.9	30.6	54	145.6	50.1	14	202.3	69.7	274	259.1	89.2
35	33.1	11.4	95	89.8	30.9	55	146.6	50.5	15	203.3	70.0	275	260.0	89.5
36	34.0	11.7	96	90.8	31.3	56	147.5	50.8	16	204.2	70.3	276	261.0	89.9
37	35.0	12.0	97	91.7	31.6	57	148.4	51.1	17	205.2	70.6	277	261.9	90.2
38	35.9	12.4	98	92.7	31.9	58	149.4	51.4	18	206.1	71.0	278	262.9	90.5
39	36.9	12.7	99	93.6	32.2	59	150.3	51.8	19	207.1	71.3	279	263.8	90.8
40	37.8	13.0	100	94.6	32.6	60	151.3	52.1	20	208.0	71.6	280	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	02	96.4	33.2	62	153.2	52.7	22	209.9	72.3	282	266.6	91.8
43	40.7	14.0	03	97.4	33.5	63	154.1	53.1	23	210.9	72.6	283	267.6	92.1
44	41.6	14.3	04	98.3	33.9	64	155.1	53.4	24	211.8	72.9	284	268.5	92.5
45	42.5	14.7	05	99.3	34.2	65	156.0	53.7	25	212.7	73.3	285	269.5	92.8
46	43.5	15.0	06	100.2	34.5	66	157.0	54.0	26	213.7	73.6	286	270.4	93.1
47	44.4	15.3	07	101.2	34.8	67	157.9	54.4	27	214.6	73.9	287	271.4	93.4
48	45.4	15.6	08	102.1	35.2	68	158.8	54.7	28	215.6	74.2	288	272.3	93.8
49	46.3	16.0	09	103.1	35.5	69	159.8	55.0	29	216.5	74.6	289	273.3	94.1
50	47.3	16.3	10	104.0	35.8	70	160.7	55.3	20	217.5	74.9	290	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	12	105.9	36.5	72	162.6	56.0	32	219.4	75.5	292	276.1	95.1
53	50.1	17.3	13	106.8	36.8	73	163.6	56.3	33	220.3	75.9	293	277.0	95.4
54	51.1	17.6	14	107.8	37.1	74	164.5	56.6	34	221.3	76.2	294	278.0	95.7
55	52.0	17.9	15	108.7	37.4	75	165.5	57.0	35	222.2	76.5	295	278.9	96.0
56	52.9	18.2	16	109.7	37.8	76	166.4	57.3	36	223.1	76.8	296	279.9	96.4
57	53.9	18.6	17	110.6	38.1	77	167.4	57.6	37	224.1	77.2	297	280.8	96.7
58	54.8	18.9	18	111.6	38.4	78	168.3	58.0	38	225.0	77.5	298	281.8	97.0
59	55.8	19.2	19	112.5	38.7	79	169.3	58.3	39	226.0	77.8	299	282.7	97.3
60	56.7	19.5	20	113.5	39.1	80	170.2	58.6	40	226.9	78.1	300	283.7	97.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 71 Degrees.)

TABLE II.

Difference of Latitude and Departure for 20 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	01.9	00.7	62	58.3	21.2	22	114.6	41.7	82	171.0	62.2	42	227.4	82.8
3	02.8	01.0	63	59.2	21.5	23	115.6	42.1	83	172.0	62.6	43	228.3	83.1
4	03.8	01.4	64	60.1	21.9	24	116.5	42.4	84	172.9	62.9	44	229.3	83.5
5	04.7	01.7	65	61.1	22.2	25	117.5	42.8	85	173.8	63.3	45	230.2	83.8
6	05.6	02.1	66	62.0	22.6	26	118.4	43.1	86	174.8	63.6	46	231.2	84.1
7	06.6	02.4	67	63.0	22.9	27	119.3	43.4	87	175.7	64.0	47	232.1	84.5
8	07.5	02.7	68	63.9	23.3	28	120.3	43.8	88	176.7	64.3	48	233.0	84.8
9	08.5	03.1	69	64.8	23.6	29	121.2	44.1	89	177.6	64.6	49	234.0	85.2
10	09.4	03.4	70	65.8	23.9	30	122.2	44.5	90	178.5	65.0	50	234.9	85.5
11	10.3	03.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	04.1	72	67.7	24.6	32	124.0	45.1	92	180.4	65.7	52	236.8	86.2
13	12.2	04.4	73	68.6	25.0	33	125.0	45.5	93	181.4	66.0	53	237.7	86.5
14	13.2	04.8	74	69.5	25.3	34	125.9	45.8	94	182.3	66.4	54	238.7	86.9
15	14.1	05.1	75	70.5	25.7	35	126.9	46.2	95	183.2	66.7	55	239.6	87.2
16	15.0	05.5	76	71.4	26.0	36	127.8	46.5	96	184.2	67.0	56	240.6	87.6
17	16.0	05.8	77	72.4	26.3	37	128.7	46.9	97	185.1	67.4	57	241.5	87.9
18	16.9	06.2	78	73.3	26.7	38	129.7	47.2	98	186.1	67.7	58	242.4	88.2
19	17.9	06.5	79	74.2	27.0	39	130.6	47.5	99	187.0	68.1	59	243.4	88.6
20	18.8	06.8	80	75.2	27.1	40	131.6	47.9	200	187.9	68.4	60	244.3	88.9
21	19.7	07.2	81	76.1	27.5	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	07.5	82	77.1	28.0	42	133.4	48.6	02	189.8	69.1	62	246.2	89.6
23	21.6	07.9	83	78.0	28.4	43	134.4	48.9	03	190.8	69.4	63	247.1	90.0
24	22.6	08.2	84	78.9	28.7	44	135.3	49.3	04	191.7	69.8	64	248.1	90.3
25	23.5	08.6	85	79.9	29.1	45	136.3	49.6	05	192.6	70.1	65	249.0	90.6
26	24.4	08.9	86	80.8	29.4	46	137.2	49.9	06	193.6	70.5	66	250.0	91.0
27	25.4	09.2	87	81.8	29.8	47	138.1	50.3	07	194.5	70.8	67	250.9	91.3
28	26.3	09.6	88	82.7	30.1	48	139.1	50.6	08	195.5	71.1	68	251.8	91.7
29	27.3	09.9	89	83.6	30.4	49	140.0	51.0	09	196.4	71.5	69	252.8	92.0
30	28.2	10.3	90	84.6	30.5	50	141.0	51.3	10	197.3	71.8	70	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254.7	92.7
32	30.1	10.9	92	86.5	31.5	52	142.8	52.0	12	199.2	72.5	72	255.6	93.0
33	31.0	11.3	93	87.4	31.8	53	143.8	52.3	13	200.2	72.9	73	256.5	93.4
34	31.9	11.6	94	88.3	32.1	54	144.7	52.7	14	201.1	73.2	74	257.5	93.7
35	32.9	12.0	95	89.3	32.5	55	145.7	53.0	15	202.0	73.5	75	258.4	94.1
36	33.8	12.3	96	90.2	32.8	56	146.6	53.4	16	203.0	73.9	76	259.4	94.4
37	34.8	12.7	97	91.2	33.2	57	147.5	53.7	17	203.9	74.2	77	260.3	94.7
38	35.7	13.0	98	92.1	33.5	58	148.5	54.0	18	204.9	74.6	78	261.2	95.1
39	36.6	13.3	99	93.0	33.9	59	149.4	54.4	19	205.8	74.9	79	262.2	95.4
40	37.6	13.7	100	94.0	34.2	60	150.4	54.7	20	206.7	75.2	80	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	02	95.8	34.9	62	152.2	55.4	22	208.6	75.9	82	265.0	96.4
43	40.4	14.7	03	96.8	35.2	63	153.2	55.7	23	209.6	76.3	83	265.9	96.8
44	41.3	15.0	04	97.7	35.6	64	154.1	56.1	24	210.5	76.6	84	266.9	97.1
45	42.3	15.4	05	98.7	35.9	65	155.0	56.4	25	211.4	77.0	85	267.8	97.5
46	43.2	15.7	06	99.6	36.3	66	156.0	56.8	26	212.4	77.3	86	268.8	97.8
47	44.2	16.1	07	100.5	36.6	67	156.9	57.1	27	213.3	77.6	87	269.7	98.2
48	45.1	16.4	08	101.5	36.9	68	157.9	57.5	28	214.2	78.0	88	270.6	98.5
49	46.0	16.8	09	102.4	37.3	69	158.8	57.8	29	215.2	78.3	89	271.6	98.8
50	47.0	17.1	10	103.4	37.6	70	159.7	58.1	30	216.1	78.7	90	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	12	105.2	38.3	72	161.6	58.8	32	218.0	79.3	92	274.4	99.9
53	49.8	18.1	13	106.2	38.6	73	162.6	59.2	33	218.9	79.7	93	275.3	100.2
54	50.7	18.5	14	107.1	39.0	74	163.5	59.5	34	219.9	80.0	94	276.3	100.6
55	51.7	18.8	15	108.1	39.3	75	164.4	59.9	35	220.8	80.4	95	277.2	100.9
56	52.6	19.2	16	109.0	39.7	76	165.4	60.2	36	221.8	80.7	96	278.1	101.2
57	53.6	19.5	17	109.9	40.0	77	166.3	60.5	37	222.7	81.1	97	279.1	101.6
58	54.5	19.8	18	110.9	40.4	78	167.3	60.9	38	223.6	81.4	98	280.0	101.9
59	55.4	20.2	19	111.8	40.7	79	168.2	61.2	39	224.6	81.7	99	281.0	102.3
60	56.4	20.5	20	112.8	41.0	80	169.1	61.6	40	225.5	82.1	300	281.9	102.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 70 Degrees]

TABLE II.

37

Difference of Latitude and Departure for 21 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	01.9	00.7	62	57.9	22.2	122	113.9	43.7	182	169.9	65.2	242	225.9	86.7
3	02.8	01.1	63	58.8	22.6	123	114.8	44.1	183	170.8	65.6	243	226.8	87.1
4	03.7	01.4	64	59.7	22.9	124	115.8	44.4	184	171.8	65.9	244	227.8	87.4
5	04.7	01.8	65	60.7	23.3	125	116.7	44.8	185	172.7	66.3	245	228.7	87.8
6	05.6	02.2	66	61.6	23.7	126	117.6	45.2	186	173.6	66.7	246	229.7	88.2
7	06.5	02.5	67	62.5	24.0	127	118.6	45.5	187	174.6	67.0	247	230.6	88.5
8	07.5	02.9	68	63.5	24.4	128	119.5	45.9	188	175.5	67.4	248	231.5	88.9
9	08.4	03.2	69	64.4	24.7	129	120.4	46.2	189	176.4	67.7	249	232.5	89.2
10	09.3	03.6	70	65.4	25.1	130	121.4	46.6	190	177.4	68.1	250	233.4	89.6
11	10.3	03.9	71	66.3	25.4	131	122.3	46.9	191	178.3	68.4	251	234.3	90.0
12	11.2	04.3	72	67.2	25.8	132	123.2	47.3	192	179.2	68.8	252	235.2	90.3
13	12.1	04.7	73	68.2	26.2	133	124.2	47.7	193	180.2	69.2	253	236.2	90.7
14	13.1	05.0	74	69.1	26.5	134	125.1	48.0	194	181.1	69.5	254	237.1	91.0
15	14.0	05.4	75	70.0	26.9	135	126.0	48.4	195	182.0	69.9	255	238.1	91.4
16	14.9	05.7	76	71.0	27.2	136	127.0	48.7	196	183.0	70.2	256	239.0	91.7
17	15.8	06.1	77	71.9	27.6	137	127.9	49.1	197	183.9	70.6	257	239.9	92.1
18	16.8	06.5	78	72.8	28.0	138	128.8	49.5	198	184.8	71.0	258	240.9	92.5
19	17.7	06.8	79	73.8	28.3	139	129.8	49.8	199	185.8	71.3	259	241.8	92.8
20	18.7	07.2	80	74.7	28.7	140	130.7	50.2	200	186.7	71.7	260	242.7	93.2
21	19.6	07.5	81	75.6	29.0	141	131.6	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	07.9	82	76.6	29.4	142	132.6	50.9	202	188.6	72.4	262	244.6	93.9
23	21.5	08.2	83	77.5	29.7	143	133.5	51.2	203	189.5	72.7	263	245.5	94.3
24	22.4	08.6	84	78.4	30.1	144	134.4	51.6	204	190.5	73.1	264	246.5	94.6
25	23.3	09.0	85	79.4	30.5	145	135.4	52.0	205	191.4	73.5	265	247.4	95.0
26	24.3	09.3	86	80.3	30.8	146	136.3	52.3	206	192.3	73.8	266	248.3	95.3
27	25.2	09.7	87	81.2	31.2	147	137.2	52.7	207	193.3	74.2	267	249.3	95.7
28	26.1	10.0	88	82.2	31.5	148	138.2	53.0	208	194.2	74.5	268	250.2	96.0
29	27.1	10.4	89	83.1	31.9	149	139.1	53.4	209	195.1	74.9	269	251.1	96.4
30	28.0	10.8	90	84.0	32.3	150	140.0	53.8	210	196.1	75.3	270	252.1	96.8
31	28.9	11.1	91	85.0	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	152	141.9	54.5	212	197.9	76.0	272	253.9	97.5
33	30.8	11.8	93	86.8	33.3	153	142.8	54.8	213	198.9	76.3	273	254.9	97.8
34	31.7	12.2	94	87.8	33.7	154	143.8	55.2	214	199.8	76.7	274	255.8	98.2
35	32.7	12.5	95	88.7	34.0	155	144.7	55.5	215	200.7	77.0	275	256.7	98.6
36	33.6	12.9	96	89.6	34.4	156	145.6	55.9	216	201.7	77.4	276	257.7	98.9
37	34.5	13.3	97	90.6	34.8	157	146.6	56.3	217	202.6	77.8	277	258.6	99.3
38	35.5	13.6	98	91.5	35.1	158	147.5	56.6	218	203.5	78.1	278	259.5	99.6
39	36.4	14.0	99	92.4	35.5	159	148.4	57.0	219	204.5	78.5	279	260.5	100.0
40	37.3	14.3	100	93.4	35.8	160	149.4	57.3	220	205.4	78.8	280	261.4	100.3
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.7
42	39.2	15.1	102	95.2	36.6	162	151.2	58.1	222	207.3	79.6	282	263.3	101.1
43	40.1	15.4	103	96.2	36.9	163	152.2	58.4	223	208.2	79.9	283	264.2	101.4
44	41.1	15.8	104	97.1	37.3	164	153.1	58.8	224	209.1	80.3	284	265.1	101.8
45	42.0	16.1	105	98.0	37.6	165	154.0	59.1	225	210.1	80.6	285	266.1	102.1
46	42.9	16.5	106	99.0	38.0	166	155.0	59.5	226	211.0	81.0	286	267.0	102.5
47	43.9	16.8	107	99.9	38.3	167	155.9	59.8	227	211.9	81.3	287	267.9	102.9
48	44.8	17.2	108	100.8	38.7	168	156.8	60.2	228	212.9	81.7	288	268.9	103.2
49	45.7	17.6	109	101.8	39.1	169	157.8	60.6	229	213.8	82.1	289	269.8	103.6
50	46.7	17.9	110	102.7	39.4	170	158.7	60.9	230	214.7	82.4	290	270.7	103.9
51	47.6	18.3	111	103.6	39.8	171	159.6	61.3	231	215.7	82.8	291	271.7	104.3
52	48.5	18.6	112	104.6	40.1	172	160.6	61.6	232	216.6	83.1	292	272.6	104.6
53	49.5	19.0	113	105.5	40.5	173	161.5	62.0	233	217.5	83.5	293	273.5	105.0
54	50.4	19.4	114	106.4	40.9	174	162.4	62.4	234	218.5	83.9	294	274.5	105.4
55	51.3	19.7	115	107.4	41.2	175	163.4	62.7	235	219.4	84.2	295	275.4	105.7
56	52.3	20.1	116	108.3	41.6	176	164.3	63.1	236	220.3	84.6	296	276.3	106.1
57	53.2	20.4	117	109.2	41.9	177	165.2	63.4	237	221.3	84.9	297	277.3	106.4
58	54.1	20.8	118	110.2	42.3	178	166.2	63.8	238	222.2	85.3	298	278.2	106.8
59	55.1	21.1	119	111.1	42.6	179	167.1	64.1	239	223.1	85.6	299	279.1	107.2
60	56.0	21.5	120	112.0	43.0	180	168.0	64.5	240	224.1	86.0	300	280.1	107.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 62 Degrees.)

TABLE II.

Difference of Latitude and Departure for 22 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 4	61	56 6	22 9	121	112 2	45 3	181	167 8	67 8	241	223 5	93 7
2	01 9	00 7	62	57 5	23 2	122	113 1	45 7	182	168 7	68 2	242	224 4	90 7
3	02 8	01 1	63	58 4	23 6	123	114 0	46 1	183	169 7	68 6	243	225 3	91 0
4	03 7	01 5	64	59 3	24 0	124	115 0	46 5	184	170 6	68 9	244	226 2	91 4
5	04 6	01 9	65	60 3	24 3	125	115 9	46 8	185	171 5	69 3	245	227 2	91 8
6	05 6	02 2	66	61 2	24 7	126	116 8	47 2	186	172 5	69 7	246	228 1	92 2
7	06 5	02 6	67	62 1	25 1	127	117 8	47 6	187	173 4	70 1	247	229 0	92 5
8	07 4	03 0	68	63 0	25 5	128	118 7	47 9	188	174 3	70 4	248	230 9	92 9
9	08 3	03 4	69	64 0	25 8	129	119 6	48 3	189	175 2	70 8	249	230 9	93 3
10	09 3	03 7	70	64 9	26 2	130	120 5	48 7	190	176 2	71 2	250	231 8	93 7
11	10 2	04 1	71	65 8	26 6	131	121 5	49 1	191	177 1	71 5	251	232 7	94 0
12	11 1	04 5	72	66 8	27 0	132	122 4	49 4	192	178 0	71 9	252	233 7	94 4
13	12 1	04 9	73	67 7	27 3	133	123 3	49 8	193	178 9	72 2	253	234 6	94 8
14	13 0	05 2	74	68 6	27 7	134	124 2	50 2	194	179 9	72 7	254	235 5	95 2
15	13 9	05 6	75	69 5	28 1	135	125 2	50 6	195	180 8	73 0	255	236 4	95 5
16	14 8	06 0	76	70 5	28 5	136	126 1	50 9	196	181 7	73 4	256	237 4	95 9
17	15 8	06 4	77	71 4	28 8	137	127 0	51 3	197	182 7	73 8	257	238 3	96 3
18	16 7	06 7	78	72 3	29 2	138	128 0	51 7	198	183 6	74 2	258	239 2	96 6
19	17 6	07 1	79	73 2	29 6	139	128 9	52 1	199	184 5	74 5	259	240 1	97 0
20	18 5	07 5	80	74 2	30 0	140	129 8	52 4	200	185 4	74 9	260	241 1	97 4
21	19 5	07 9	81	75 1	30 3	141	130 7	52 8	201	186 4	75 3	261	242 0	97 8
22	20 4	08 2	82	76 0	30 7	142	131 7	53 2	202	187 3	75 7	262	242 9	98 1
23	21 3	08 6	83	77 0	31 1	143	132 6	53 6	203	188 2	76 0	263	243 8	98 5
24	22 3	09 0	84	77 9	31 5	144	133 5	53 9	204	189 1	76 4	264	244 8	98 9
25	23 2	09 4	85	78 8	31 8	145	134 4	54 3	205	190 1	76 8	265	245 7	99 3
26	24 1	09 7	86	79 7	32 2	146	135 4	54 7	206	191 0	77 2	266	246 6	99 6
27	25 0	10 1	87	80 7	32 5	147	136 3	55 1	207	191 9	77 5	267	247 6	100 0
28	26 0	10 5	88	81 6	33 0	148	137 2	55 4	208	192 9	77 9	268	248 5	100 4
29	26 9	10 9	89	82 5	33 3	149	138 2	55 8	209	193 8	78 3	269	249 4	100 8
30	27 8	11 2	90	83 4	33 7	150	139 1	56 2	210	194 7	78 7	270	250 3	101 1
31	28 7	11 6	91	84 4	34 1	151	140 0	56 6	211	195 6	79 0	271	251 3	101 5
32	29 7	12 0	92	85 3	34 5	152	140 9	56 9	212	196 6	79 4	272	252 2	101 9
33	30 6	12 4	93	86 2	34 8	153	141 9	57 3	213	197 5	79 8	273	253 1	102 3
34	31 5	12 7	94	87 2	35 2	154	142 8	57 7	214	198 4	80 2	274	254 0	102 6
35	32 5	13 1	95	88 1	35 6	155	143 7	58 1	215	199 3	80 5	275	255 0	103 0
36	33 4	13 5	96	89 0	36 0	156	144 6	58 4	216	200 3	80 9	276	255 9	103 4
37	34 3	13 9	97	89 9	36 3	157	145 6	58 8	217	201 2	81 3	277	256 8	103 8
38	35 2	14 2	98	90 0	36 7	158	146 5	59 2	218	202 1	81 7	278	257 8	104 1
39	36 2	14 6	99	91 8	37 1	159	147 4	59 6	219	203 1	82 0	279	258 7	104 5
40	37 1	15 0	100	92 7	37 5	160	148 3	59 9	220	204 0	82 4	280	259 6	104 9
41	38 0	15 4	101	93 6	37 8	161	149 3	60 3	221	204 9	82 8	281	260 5	105 3
42	38 9	15 7	102	94 6	38 2	162	150 2	60 7	222	205 8	83 2	282	261 5	105 6
43	39 9	16 1	103	95 5	38 6	163	151 1	61 1	223	206 8	83 5	283	262 4	106 0
44	40 8	16 5	104	96 4	39 0	164	152 1	61 4	224	207 7	83 9	284	263 3	106 4
45	41 7	16 9	105	97 4	39 3	165	153 0	61 8	225	208 6	84 3	285	264 2	106 8
46	42 7	17 2	106	98 3	39 7	166	153 9	62 2	226	209 5	84 7	286	265 1	107 1
47	43 6	17 6	107	99 2	40 1	167	154 8	62 6	227	210 5	85 0	287	266 1	107 5
48	44 5	18 0	108	100 1	40 5	168	155 8	62 9	228	211 4	85 4	288	267 0	107 9
49	45 4	18 4	109	101 1	40 8	169	156 7	63 3	229	212 3	85 8	289	268 0	108 3
50	46 4	18 7	110	102 0	41 2	170	157 6	63 7	230	213 3	86 2	290	269 9	108 6
51	47 3	19 1	111	102 9	41 6	171	158 5	64 1	231	214 2	86 5	291	269 8	109 0
52	48 2	19 5	112	103 8	42 0	172	159 5	64 4	232	215 1	86 9	292	270 7	109 4
53	49 1	19 9	113	104 8	42 3	173	160 4	64 8	233	216 0	87 3	293	271 7	109 8
54	50 1	20 2	114	105 7	42 7	174	161 3	65 2	234	217 0	87 7	294	272 6	110 1
55	51 0	20 6	115	106 6	43 1	175	162 3	65 6	235	217 9	88 0	295	273 5	110 5
56	51 9	21 0	116	107 6	43 5	176	163 2	65 9	236	218 8	88 4	296	274 4	110 9
57	52 8	21 4	117	108 5	43 8	177	164 1	66 3	237	219 7	88 8	297	275 4	111 3
58	53 8	21 7	118	109 4	44 2	178	165 0	66 7	238	220 7	89 2	298	276 3	111 6
59	54 7	22 1	119	110 3	44 6	179	166 0	67 1	239	221 6	89 5	299	277 2	112 0
60	55 6	22 5	120	111 3	45 0	180	166 9	67 4	240	222 5	89 9	300	278 2	112 4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 68 Degrees.]

TABLE II.

39

Difference of Latitude and Departure for 23 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.2	23.8	121	111.4	47.3	181	166.6	70.7	241	221.8	94.2
2	01.8	00.8	62	57.1	24.2	122	112.3	47.7	82	167.5	71.1	42	222.8	94.6
3	02.8	01.2	63	58.0	24.6	123	113.2	48.1	83	168.5	71.5	43	223.7	94.9
4	03.7	01.6	64	58.9	25.0	124	114.1	48.5	84	169.4	71.9	44	224.6	95.3
5	04.6	02.0	65	59.8	25.4	125	115.1	48.8	85	170.3	72.3	45	225.5	95.7
6	05.5	02.3	66	60.8	25.8	126	116.0	49.2	86	171.2	72.7	46	226.4	96.1
7	06.4	02.7	67	61.7	26.2	127	116.9	49.6	87	172.1	73.1	47	227.4	96.5
8	07.4	03.1	68	62.6	26.6	128	117.8	50.0	88	173.1	73.5	48	228.3	96.9
9	08.3	03.5	69	63.5	27.0	129	118.7	50.4	89	174.0	73.8	49	229.2	97.3
10	09.2	03.9	70	64.4	27.4	130	119.7	50.8	90	174.9	74.2	50	230.1	97.7
11	10.1	04.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	04.7	72	66.3	28.1	132	121.5	51.6	92	176.7	75.0	52	232.0	98.5
13	12.0	05.1	73	67.2	28.5	133	122.4	52.0	93	177.7	75.4	53	233.0	98.9
14	12.9	05.5	74	68.1	28.9	134	123.3	52.4	94	178.6	75.8	54	233.8	99.2
15	13.8	05.9	75	69.0	29.3	135	124.3	52.7	95	179.5	76.2	55	234.7	99.6
16	14.7	06.3	76	70.0	29.7	136	125.2	53.1	96	180.4	76.6	56	235.6	100.0
17	15.6	06.6	77	70.9	30.1	137	126.1	53.5	97	181.3	77.0	57	236.6	100.4
18	16.5	07.0	78	71.8	30.5	138	127.0	53.9	182	182.3	77.4	58	237.5	100.8
19	17.4	07.4	79	72.7	30.9	139	128.0	54.3	183	183.2	77.8	59	238.4	101.2
20	18.4	07.8	80	73.6	31.3	140	128.9	54.7	200	184.1	78.1	60	239.3	101.6
21	19.3	08.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.3	102.0
22	20.3	08.6	82	75.5	32.0	142	130.7	55.5	02	185.9	78.9	62	241.2	102.4
23	21.2	09.0	83	76.4	32.4	143	131.6	55.9	03	186.9	79.3	63	242.1	102.8
24	22.1	09.4	84	77.3	32.8	144	132.6	56.3	04	187.8	79.7	64	243.0	103.2
25	23.0	09.8	85	78.2	33.2	145	133.5	56.7	05	188.7	80.1	65	243.9	103.5
26	23.9	10.2	86	79.2	33.6	146	134.4	57.0	06	189.6	80.5	66	244.9	103.9
27	24.9	10.5	87	80.1	34.0	147	135.3	57.4	07	190.5	80.9	67	245.8	104.3
28	25.8	10.9	88	81.0	34.4	148	136.2	57.8	08	191.5	81.3	68	246.7	104.7
29	26.7	11.3	89	81.9	34.8	149	137.2	58.2	09	192.4	81.7	69	247.6	105.1
30	27.6	11.7	90	82.8	35.2	150	138.1	58.6	10	193.3	82.1	70	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	152	139.9	59.4	12	195.1	82.8	72	250.4	106.3
33	30.4	12.9	93	85.6	36.3	153	140.8	59.8	13	196.1	83.2	73	251.3	106.7
34	31.3	13.3	94	86.5	36.7	154	141.8	60.2	14	197.0	83.6	74	252.2	107.1
35	32.2	13.7	95	87.4	37.1	155	142.7	60.6	15	197.9	84.0	75	253.1	107.5
36	33.1	14.1	96	88.3	37.5	156	143.6	61.0	16	198.8	84.4	76	254.1	107.8
37	34.1	14.5	97	89.3	37.9	157	144.5	61.3	17	199.7	84.8	77	255.0	108.2
38	35.0	14.8	98	90.2	38.3	158	145.4	61.7	18	200.7	85.2	78	255.9	108.6
39	35.9	15.2	99	91.1	38.7	159	146.4	62.1	19	201.6	85.6	79	256.8	109.0
40	36.8	15.6	100	92.1	39.1	160	147.3	62.5	20	202.5	86.0	80	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.4	281	258.7	109.8
42	38.7	16.4	02	93.9	39.9	162	149.1	63.3	22	204.4	86.7	82	259.6	110.2
43	39.6	16.8	03	94.8	40.2	163	150.0	63.7	23	205.3	87.1	83	260.5	110.6
44	40.5	17.2	04	95.7	40.6	164	151.0	64.1	24	206.2	87.5	84	261.4	111.0
45	41.4	17.6	05	96.7	41.0	165	151.9	64.5	25	207.1	87.9	85	262.3	111.4
46	42.3	18.0	06	97.6	41.4	166	152.8	64.9	26	208.0	88.3	86	263.3	111.7
47	43.3	18.4	07	98.5	41.8	167	153.7	65.3	27	209.0	88.7	87	264.2	112.1
48	44.2	18.8	08	99.4	42.2	168	154.6	65.6	28	209.9	89.1	88	265.1	112.5
49	45.1	19.1	09	100.3	42.6	169	155.6	66.0	29	210.8	89.5	89	266.0	112.9
50	46.0	19.5	10	101.3	43.0	170	156.5	66.4	30	211.7	89.9	90	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	12	103.1	43.8	172	158.3	67.2	32	213.6	90.6	92	268.8	114.1
53	48.8	20.7	13	104.0	44.2	173	159.2	67.6	33	214.5	91.0	93	269.7	114.5
54	49.7	21.1	14	104.9	44.6	174	160.2	68.0	34	215.4	91.4	94	270.6	114.9
55	50.6	21.5	15	105.9	44.9	175	161.1	68.4	35	216.3	91.8	95	271.5	115.3
56	51.5	21.9	16	106.8	45.3	176	162.0	68.8	36	217.2	92.2	96	272.5	115.7
57	52.5	22.3	17	107.7	45.7	177	162.9	69.2	37	218.2	92.6	97	273.4	116.0
58	53.4	22.7	18	108.6	46.1	178	163.8	69.6	38	219.1	93.0	98	274.3	116.4
59	54.3	23.1	19	109.5	46.5	179	164.8	69.9	39	220.0	93.4	99	275.2	116.8
60	55.2	23.4	20	110.5	46.9	180	165.7	70.3	40	220.9	93.8	300	276.2	117.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 67 Degrees)

TABLE II.

Difference of Latitude and Departure for 24 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00.4	61	55 7	24 8	121	110 5	49 2	181	165.4	73.6	241	220.2	98 0
2	01 8	00 8	62	56 6	25 2	122	111 5	49 6	182	166 3	74 0	242	221.1	98 4
3	02 7	01.2	63	57 6	25 6	123	112 4	50 0	183	167 2	74.4	243	222 0	98 8
4	03 7	01.6	64	58 5	26 0	124	113 3	50.4	184	168 1	74.8	244	222.9	99 2
5	04 6	02 0	65	59 4	26 4	125	114 2	50 8	185	169 0	75 2	245	223.8	99 7
6	05 5	02.4	66	60 3	26 8	126	115 1	51.2	186	169 9	75 7	246	224 7	100 1
7	06 4	02.8	67	61 2	27 3	127	116 0	51.7	187	170 8	75.1	247	225.6	100 5
8	07 3	03 3	68	62 1	27.7	128	116 9	52.1	188	171 7	75.5	248	226 5	100 9
9	08 2	03 7	69	63 0	28 1	129	117 8	52 5	189	172 7	75.9	249	227 5	101 3
10	09 1	04 1	70	63 9	28 5	130	118 8	52 9	190	173 6	77 3	250	228 4	101 7
11	10 0	04.5	71	64 9	28 9	131	119 7	53 3	191	174 5	77 7	251	229 3	102 1
12	11 0	04 9	72	65 8	29 3	132	120 6	53 7	192	175 4	78.1	252	230 2	102 5
13	11 9	05 3	73	66 7	29 7	133	121 5	54 1	193	176 3	78 5	253	231.1	102 9
14	12 8	05 7	74	67 6	30 1	134	122 4	54.5	194	177 2	78.9	254	232 0	103 3
15	13 7	06 1	75	68 5	30 5	135	123 3	54 9	195	178 1	79.3	255	233 0	103 7
16	14 6	06 5	76	69 4	30 9	136	124 2	55 3	196	179 1	79.7	256	233.9	104 1
17	15 5	06 9	77	70 3	31 3	137	125 2	55.7	197	180 0	80 1	257	234.8	104 5
18	16 4	07 3	78	71 3	31.7	138	126 1	56 1	198	180 9	80.5	258	235 7	104 9
19	17 4	07 7	79	72 2	32 1	139	127 0	56 5	199	181 8	80.9	259	236 6	105 3
20	18 3	08 1	80	73 1	32 5	140	127 9	56 9	200	182 7	81.3	260	237 5	105 7
21	19 2	08 5	81	74 0	32 9	141	128 8	57 3	201	183 6	81 8	261	238 4	106 1
22	20 1	08 9	82	74 9	33 4	142	129 7	57 8	202	184 5	82.2	262	239 3	106 5
23	21 0	09 4	83	75 8	33.8	143	130 6	58 2	203	185 4	82.6	263	240 3	107 0
24	21 9	09 8	84	76 7	34.2	144	131 5	58 6	204	186 4	83 0	264	241 2	107 4
25	22 8	10 2	85	77 7	34.6	145	132 4	59 0	205	187 3	83.4	265	242 1	107 8
26	23 8	10 6	86	78 6	35 0	146	133 3	59.4	206	188 2	83.8	266	243 0	108 2
27	24 7	11 0	87	79 5	35.4	147	134 2	59.8	207	189 1	84 2	267	243 9	108 6
28	25 6	11 4	88	80 4	35 8	148	135 2	60.2	208	190 0	84 6	268	244 8	109 0
29	26 5	11 8	89	81 3	36 2	149	136 1	60 6	209	190 9	85 0	269	245 7	109 4
30	27 4	12 2	90	82 2	36 6	150	137 0	61 0	210	191 8	85.4	270	246 6	109 8
31	28 3	12 6	91	83 1	37 0	151	137 9	61 4	211	192 8	85.8	271	247 5	110 2
32	29 2	13 0	92	84 0	37 4	152	138 8	61 8	212	193 7	86 2	272	248 4	110 6
33	30 1	13 4	93	85 0	37 8	153	139 8	62 2	213	194 6	86 6	273	249 3	111 0
34	31 1	13 8	94	85 9	38 2	154	140 7	62 6	214	195 5	87 0	274	250 2	111 4
35	32 0	14 2	95	86 8	38 6	155	141 6	63 0	215	196 4	87 4	275	251 1	111 8
36	32 9	14 6	96	87 7	39 0	156	142 5	63 5	216	197 3	87.9	276	252 0	112 2
37	33 8	15 0	97	88 6	39 5	157	143 4	63.9	217	198 2	88.3	277	253 0	112 6
38	34 7	15 5	98	89 5	39.9	158	144 3	64.3	218	199 1	88.7	278	254 0	113 0
39	35 6	15 9	99	90 4	40 3	159	145 2	64 7	219	200 0	89 1	279	255 0	113 4
40	36 5	16 3	100	91 3	40 7	160	146 1	65 1	220	201 0	89 5	280	256 0	113 8
41	37 5	16 7	101	92 3	41 1	161	147 1	65.5	221	201 9	89 9	281	257 0	114 2
42	38 4	17 1	102	93 2	41 5	162	148 0	65.9	222	202 8	90.3	282	258 0	114 6
43	39 3	17 5	103	94 1	41 9	163	148 9	66 3	223	203 7	90 7	283	259 0	115 0
44	40 2	17 9	104	95 0	42 3	164	149 8	66 7	224	204 6	91.1	284	260 0	115 4
45	41 1	18 3	105	95 9	42 7	165	150 7	67.1	225	205 5	91.5	285	261 0	115 8
46	42 0	18 7	106	96 8	43 1	166	151 6	67 5	226	206 4	91.9	286	262 0	116 2
47	42 9	19 1	107	97 7	43 5	167	152 5	67.9	227	207 3	92.3	287	263 0	116 6
48	43 8	19 5	108	98 6	43 9	168	153 4	68.3	228	208 2	92.7	288	264 0	117 0
49	44 7	19 9	109	99 5	44 3	169	154 3	68 7	229	209 1	93 1	289	265 0	117 4
50	45 6	20 3	110	100 4	44 7	170	155 2	69 1	230	210 0	93 5	290	266 0	117 8
51	46 5	20 7	111	101 3	45 1	171	156 1	69.5	231	211 0	94 0	291	267 0	118 2
52	47 4	21 2	112	102 2	45 5	172	157 1	70 0	232	211 9	94 4	292	268 0	118 6
53	48 3	21 6	113	103 1	45 9	173	158 0	70.4	233	212 8	94 8	293	269 0	119 0
54	49 2	22 0	114	104 0	46 3	174	159 0	70 8	234	213 7	95 2	294	270 0	119 4
55	50 1	22 4	115	105 0	46 7	175	159 9	71 2	235	214 6	95.6	295	271 0	119 8
56	51 0	22 8	116	106 0	47 1	176	160 8	71 6	236	215 5	96 0	296	272 0	120 2
57	51 9	23 2	117	106 9	47 5	177	161 7	72 0	237	216 4	96.4	297	273 0	120 6
58	52 8	23 6	118	107 8	47 9	178	162 6	72.4	238	217 3	96.8	298	274 0	121 0
59	53 7	24 0	119	108 7	48 3	179	163 5	72.8	239	218 2	97.2	299	275 0	121 4
60	54 6	24 4	120	109 6	48 7	180	164 4	73 2	240	219 1	97.6	300	276 0	121 8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 66 Degrees.]

TABLE II.

41

Difference of Latitude and Departure for 25 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 4	61	55 3	25 8	121	109 7	51 1	181	164 0	76 5	241	218 4	101 9
2	01 8	00 8	62	56 2	26 2	122	110 6	51 6	82	164 9	76 9	42	219 3	102 3
3	02 7	01 3	63	57 1	26 6	123	111 5	52 0	83	165 9	77 3	43	220 2	102 7
4	03 6	01 7	64	58 0	27 0	124	112 4	52 4	84	166 8	77 8	44	221 1	103 1
5	04 5	02 1	65	58 9	27 5	125	113 3	52 8	85	167 7	78 2	45	222 0	103 5
6	05 4	02 5	66	59 8	27 9	126	114 2	53 2	86	168 6	78 6	46	223 0	104 0
7	06 3	03 0	67	60 7	28 3	127	115 1	53 7	87	169 5	79 0	47	223 9	104 4
8	07 3	03 4	68	61 6	28 7	128	116 0	54 1	88	170 4	79 5	48	224 8	104 8
9	08 2	03 8	69	62 5	29 1	129	116 9	54 5	89	171 3	79 9	49	225 7	105 2
10	09 1	04 2	70	63 4	29 6	130	117 8	54 9	90	172 2	80 3	50	226 6	105 7
11	10 0	04 6	71	64 3	30 0	131	118 7	55 4	191	173 1	80 7	251	227 5	106 1
12	10 9	05 1	72	65 3	30 4	132	119 6	55 8	92	174 0	81 1	62	228 4	106 5
13	11 8	05 5	73	66 2	30 9	133	120 5	56 2	93	174 9	81 6	53	229 3	106 9
14	12 7	05 9	74	67 1	31 3	134	121 4	56 6	94	175 8	82 0	54	230 2	107 3
15	13 6	06 3	75	68 0	31 7	135	122 3	57 1	95	176 7	82 4	55	231 1	107 8
16	14 5	06 8	76	68 9	32 1	136	123 2	57 5	96	177 6	82 8	56	232 0	108 2
17	15 4	07 2	77	69 8	32 5	137	124 1	57 9	97	178 5	83 3	57	232 9	108 6
18	16 3	07 6	78	70 7	33 0	138	125 0	58 3	98	179 4	83 7	58	233 8	109 0
19	17 2	08 0	79	71 6	33 4	139	126 0	58 7	99	180 3	84 1	59	234 7	109 5
20	18 1	08 5	80	72 5	33 8	140	126 9	59 2	200	181 2	84 5	60	235 6	109 9
21	19 0	09 0	81	73 4	34 2	141	127 8	59 6	201	182 1	84 9	261	236 5	110 3
22	19 9	09 5	82	74 3	34 7	142	128 7	60 0	02	183 0	85 4	62	237 4	110 7
23	20 8	09 9	83	75 2	35 1	143	129 6	60 4	03	184 0	85 8	63	238 3	111 1
24	21 7	10 1	84	76 1	35 5	144	130 5	60 9	04	184 9	86 2	64	239 2	111 6
25	22 6	10 6	85	77 0	35 9	145	131 4	61 3	05	185 8	86 6	65	240 1	112 0
26	23 5	11 0	86	77 9	36 3	146	132 3	61 7	06	186 7	87 1	66	241 0	112 4
27	24 4	11 4	87	78 8	36 8	147	133 2	62 1	07	187 6	87 5	67	242 0	112 8
28	25 3	11 8	88	79 7	37 2	148	134 1	62 5	08	188 5	87 9	68	242 9	113 3
29	26 2	12 3	89	80 6	37 6	149	135 0	63 0	09	189 4	88 3	69	243 8	113 7
30	27 1	12 7	90	81 5	38 0	150	135 9	63 4	10	190 3	88 7	70	244 7	114 1
31	28 0	13 1	91	82 4	38 5	151	136 8	63 8	211	191 2	89 2	271	245 6	114 5
32	29 0	13 5	92	83 3	38 9	152	137 7	64 2	12	192 1	89 6	72	246 5	115 0
33	29 9	13 9	93	84 2	39 3	153	138 6	64 7	13	193 0	90 0	73	247 4	115 4
34	30 8	14 4	94	85 1	39 7	154	139 5	65 1	14	193 9	90 4	74	248 3	115 8
35	31 7	14 8	95	86 0	40 1	155	140 4	65 5	15	194 8	90 9	75	249 2	116 2
36	32 6	15 2	96	86 9	40 6	156	141 3	65 9	16	195 7	91 3	76	250 1	116 6
37	33 5	15 6	97	87 8	41 0	157	142 2	66 4	17	196 6	91 7	77	251 0	117 1
38	34 4	16 1	98	88 7	41 4	158	143 1	66 8	18	197 5	92 1	78	252 0	117 5
39	35 3	16 5	99	89 6	41 8	159	144 0	67 2	19	198 4	92 6	79	252 9	117 9
40	36 2	16 9	100	90 5	42 3	160	145 0	67 6	20	199 3	93 0	80	253 8	118 3
41	37 1	17 3	101	91 4	42 7	161	145 9	68 0	211	200 2	93 4	281	254 7	118 7
42	38 0	17 7	102	92 3	43 1	162	146 8	68 5	22	201 1	93 8	82	255 6	119 2
43	39 0	18 2	103	93 2	43 5	163	147 7	68 9	23	202 0	94 2	83	256 5	119 6
44	39 9	18 6	104	94 1	44 0	164	148 6	69 3	24	203 0	94 7	84	257 4	120 0
45	40 8	19 0	105	95 0	44 4	165	149 5	69 7	25	203 9	95 1	85	258 3	120 4
46	41 7	19 4	106	95 9	44 8	166	150 4	70 2	26	204 8	95 5	86	259 2	120 8
47	42 6	19 9	107	96 8	45 2	167	151 3	70 6	27	205 7	95 9	87	260 1	121 3
48	43 5	20 3	108	97 7	45 6	168	152 2	71 0	28	206 6	96 4	88	261 0	121 7
49	44 4	20 7	109	98 6	46 1	169	153 1	71 4	29	207 5	96 8	89	261 9	122 1
50	45 3	21 1	110	99 5	46 5	170	154 0	71 8	30	208 4	97 2	90	262 8	122 6
51	46 2	21 6	111	100 4	46 9	171	155 0	72 3	231	209 3	97 6	291	263 7	123 0
52	47 1	22 0	112	101 3	47 3	172	155 9	72 7	32	210 2	98 0	92	264 6	123 4
53	48 0	22 4	113	102 2	47 8	173	156 8	73 1	33	211 1	98 5	93	265 5	123 8
54	48 9	22 8	114	103 1	48 2	174	157 7	73 5	34	212 0	98 9	94	266 4	124 2
55	49 8	23 2	115	104 0	48 6	175	158 6	74 0	35	213 0	99 3	95	267 3	124 7
56	50 7	23 7	116	104 9	49 0	176	159 5	74 4	36	213 9	99 7	96	268 2	125 1
57	51 6	24 1	117	105 8	49 4	177	160 4	74 8	37	214 8	100 2	97	269 1	125 5
58	52 5	24 5	118	106 7	49 9	178	161 3	75 2	38	215 7	100 6	98	270 0	125 9
59	53 4	24 9	119	107 6	50 3	179	162 2	75 6	39	216 6	101 0	99	271 0	126 4
60	54 3	25 4	120	108 5	50 7	180	163 1	76 1	40	217 5	101 4	300	271 9	126 8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 63 Degrees.]

TABLE II.

Difference of Latitude and Departure for 26 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 4	61	54.8	26 7	121	108 8	53 0	181	162 7	79 3	241	216 6	106 6
2	01 8	00 9	62	55 7	27 2	122	109 7	53 5	82	163 6	79 8	242	217 5	106 1
3	02 7	01 3	63	56 6	28 1	123	110 6	54 0	83	164 5	80 2	243	218 4	105 5
4	03 6	01 8	64	57 5	28 6	124	111 5	54 4	84	165 4	80 7	244	219 3	105 0
5	04 5	02 2	65	58 4	29 0	125	112 3	54 8	85	166 3	81 1	245	220 2	104 4
6	05 4	02 6	66	59 3	29 5	126	113 2	55 2	86	167 2	81 6	246	221 1	103 8
7	06 3	03 1	67	60 2	30 0	127	114 1	55 7	87	168 1	82 0	247	222 0	103 3
8	07 2	03 5	68	61 1	30 5	128	115 0	56 1	88	169 0	82 5	248	223 0	102 7
9	08 1	03 9	69	62 0	31 0	129	115 9	56 5	89	169 9	82 9	249	223 9	102 2
10	09 0	04 4	70	62 9	31 5	130	116 8	57 0	90	170 8	83 3	250	224 7	101 6
11	09 9	04 8	71	63 8	32 0	131	117 7	57 4	91	171 7	83 7	251	225 6	101 0
12	10 8	05 3	72	64 7	32 5	132	118 6	57 9	92	172 6	84 2	252	226 5	100 5
13	11 7	05 7	73	65 6	33 0	133	119 5	58 3	93	173 5	84 6	253	227 4	100 0
14	12 6	06 1	74	66 5	33 5	134	120 4	58 7	94	174 4	85 0	254	228 3	99 5
15	13 5	06 6	75	67 4	34 0	135	121 3	59 2	95	175 3	85 5	255	229 2	99 0
16	14 4	07 0	76	68 3	34 5	136	122 2	59 6	96	176 2	85 9	256	230 1	98 5
17	15 3	07 5	77	69 2	35 0	137	123 1	60 1	97	177 1	86 4	257	231 0	98 0
18	16 2	07 9	78	70 1	35 5	138	124 0	60 5	98	178 0	86 8	258	231 9	97 5
19	17 1	08 3	79	71 0	36 0	139	124 9	60 9	99	178 9	87 2	259	232 8	97 0
20	18 0	08 8	80	71 9	36 5	140	125 8	61 4	200	179 8	87 7	260	233 7	96 5
21	18 9	09 2	81	72 8	37 0	141	126 7	61 8	201	180 7	88 1	261	234 6	96 0
22	19 8	09 6	82	73 7	37 5	142	127 6	62 2	202	181 6	88 6	262	235 5	95 5
23	20 7	10 1	83	74 6	38 0	143	128 5	62 7	203	182 5	89 0	263	236 4	95 0
24	21 6	10 5	84	75 5	38 5	144	129 4	63 1	204	183 4	89 5	264	237 3	94 5
25	22 5	11 0	85	76 4	39 0	145	130 3	63 6	205	184 3	89 9	265	238 2	94 0
26	23 4	11 4	86	77 3	39 5	146	131 2	64 0	206	185 2	90 3	266	239 1	93 5
27	24 3	11 8	87	78 2	40 0	147	132 1	64 4	207	186 1	90 7	267	240 0	93 0
28	25 2	12 3	88	79 1	40 5	148	133 0	64 9	208	186 9	91 2	268	240 9	92 5
29	26 1	12 7	89	80 0	41 0	149	133 9	65 3	209	187 8	91 6	269	241 8	92 0
30	27 0	13 2	90	80 9	41 5	150	134 8	65 8	210	188 7	92 1	270	242 7	91 5
31	27 9	13 6	91	81 8	42 0	151	135 7	66 2	211	189 6	92 5	271	243 6	91 0
32	28 8	14 0	92	82 7	42 5	152	136 6	66 6	212	190 5	92 9	272	244 5	90 5
33	29 7	14 5	93	83 6	43 0	153	137 5	67 1	213	191 4	93 3	273	245 4	90 0
34	30 6	14 9	94	84 5	43 5	154	138 4	67 5	214	192 3	93 7	274	246 3	89 5
35	31 5	15 3	95	85 4	44 0	155	139 3	67 9	215	193 2	94 1	275	247 2	89 0
36	32 4	15 8	96	86 3	44 5	156	140 2	68 4	216	194 1	94 5	276	248 1	88 5
37	33 3	16 2	97	87 2	45 0	157	141 1	68 8	217	195 0	94 9	277	249 0	88 0
38	34 2	16 7	98	88 1	45 5	158	142 0	69 3	218	195 9	95 3	278	250 0	87 5
39	35 1	17 1	99	89 0	46 0	159	142 9	69 7	219	196 8	95 7	279	250 9	87 0
40	36 0	17 5	100	89 9	46 5	160	143 8	70 1	220	197 7	96 1	280	251 8	86 5
41	36 9	18 0	101	90 8	47 0	161	144 7	70 6	221	198 6	96 5	281	252 7	86 0
42	37 7	18 4	102	91 7	47 5	162	145 6	71 0	222	199 5	96 9	282	253 6	85 5
43	38 6	18 8	103	92 6	48 0	163	146 5	71 5	223	200 4	97 3	283	254 5	85 0
44	39 5	19 3	104	93 5	48 5	164	147 4	71 9	224	201 3	97 7	284	255 4	84 5
45	40 4	19 7	105	94 4	49 0	165	148 3	72 3	225	202 2	98 1	285	256 3	84 0
46	41 3	20 2	106	95 3	49 5	166	149 2	72 8	226	203 1	98 5	286	257 2	83 5
47	42 2	20 6	107	96 2	50 0	167	150 1	73 2	227	204 0	98 9	287	258 1	83 0
48	43 1	21 0	108	97 1	50 5	168	151 0	73 6	228	204 9	99 3	288	259 0	82 5
49	44 0	21 5	109	98 0	51 0	169	151 9	74 1	229	205 8	99 7	289	260 0	82 0
50	44 9	21 9	110	98 9	51 5	170	152 8	74 5	230	206 7	100 1	290	260 9	81 5
51	45 8	22 4	111	99 8	52 0	171	153 7	75 0	231	207 6	100 5	291	261 8	81 0
52	46 7	22 8	112	100 7	52 5	172	154 6	75 4	232	208 5	100 9	292	262 7	80 5
53	47 6	23 3	113	101 6	53 0	173	155 5	75 8	233	209 4	101 3	293	263 6	80 0
54	48 5	23 7	114	102 5	53 5	174	156 4	76 3	234	210 3	101 7	294	264 5	79 5
55	49 4	24 1	115	103 4	54 0	175	157 3	76 7	235	211 2	102 1	295	265 4	79 0
56	50 3	24 6	116	104 3	54 5	176	158 2	77 2	236	212 1	102 5	296	266 3	78 5
57	51 2	25 0	117	105 2	55 0	177	159 1	77 6	237	213 0	102 9	297	267 2	78 0
58	52 1	25 4	118	106 1	55 5	178	160 0	78 1	238	213 9	103 3	298	268 1	77 5
59	53 0	25 9	119	107 0	56 0	179	160 9	78 5	239	214 8	103 7	299	269 0	77 0
60	53 9	26 3	120	107 9	56 5	180	161 8	78 9	240	215 7	104 1	300	270 0	76 5

[For 64 Degrees.]

TABLE II.

43

Difference of Latitude and Departure for 27 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.3	81	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	01.8	00.9	82	55.2	28.1	22	108.7	55.4	82	162.2	82.8	42	215.6	109.9
3	02.7	01.4	83	56.1	28.6	23	109.6	55.8	83	163.1	83.4	43	216.5	110.3
4	03.6	01.8	84	57.0	29.1	24	110.5	56.3	84	163.9	83.9	44	217.4	110.8
5	04.5	02.3	85	57.9	29.5	25	111.4	56.7	85	164.8	84.4	45	218.3	111.2
6	05.3	02.7	86	58.8	30.0	26	112.3	57.2	86	165.7	84.9	46	219.2	111.7
7	06.2	03.2	87	59.7	30.4	27	113.2	57.7	87	166.6	84.9	47	220.1	112.1
8	07.1	03.6	88	60.6	30.9	28	114.0	58.1	88	167.5	85.4	48	221.0	112.6
9	08.0	04.1	89	61.5	31.3	29	114.9	58.6	89	168.4	85.8	49	221.9	113.0
10	08.9	04.5	90	62.4	31.8	30	115.8	59.0	90	169.3	86.2	50	222.8	113.5
11	09.8	05.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	05.4	72	64.2	32.7	32	117.6	59.9	92	171.1	87.2	62	224.5	114.4
13	11.6	05.9	73	65.0	33.1	33	118.5	60.4	93	172.0	87.7	63	225.4	114.9
14	12.5	06.4	74	65.9	33.6	34	119.4	60.8	94	172.9	88.1	64	226.3	115.3
15	13.4	06.8	75	66.8	34.0	35	120.3	61.3	95	173.7	88.5	65	227.2	115.8
16	14.3	07.3	76	67.7	34.5	36	121.2	61.7	96	174.6	89.0	66	228.1	116.2
17	15.1	07.7	77	68.6	35.0	37	122.1	62.2	97	175.5	89.4	67	229.0	116.7
18	16.0	08.2	78	69.5	35.4	38	123.0	62.7	98	176.4	89.9	68	229.9	117.1
19	16.9	08.7	79	70.4	35.9	39	123.8	63.1	99	177.3	90.3	69	230.8	117.6
20	17.8	09.1	80	71.3	36.3	40	124.7	63.6	200	178.2	90.8	70	231.7	118.0
21	18.7	09.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	42	126.5	64.5	180	180.0	91.7	62	233.4	118.9
23	20.5	10.4	83	74.0	37.7	43	127.4	64.9	03	180.9	92.2	63	234.3	119.4
24	21.4	10.9	84	74.8	38.1	44	128.3	65.4	04	181.8	92.6	64	235.2	119.9
25	22.3	11.3	85	75.7	38.6	45	129.2	65.8	05	182.7	93.1	65	236.1	120.3
26	23.2	11.8	86	76.6	39.0	46	130.1	66.3	06	183.5	93.5	66	237.0	120.8
27	24.1	12.3	87	77.5	39.5	47	131.0	66.7	07	184.4	94.0	67	237.9	121.2
28	24.9	12.7	88	78.4	40.0	48	131.9	67.2	08	185.3	94.4	68	238.8	121.7
29	25.8	13.2	89	79.3	40.4	49	132.8	67.6	09	186.2	94.9	69	239.7	122.1
30	26.7	13.7	90	80.2	40.9	50	133.7	68.1	10	187.1	95.3	70	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.6	92	82.0	41.8	52	135.4	69.0	11	188.9	96.3	72	242.4	123.5
33	29.4	15.0	93	82.9	42.2	53	136.3	69.5	12	189.8	96.7	73	243.3	123.9
34	30.3	15.4	94	83.8	42.7	54	137.2	69.9	13	190.7	97.2	74	244.2	124.4
35	31.2	15.9	95	84.6	43.1	55	138.1	70.4	14	191.6	97.6	75	245.1	124.8
36	32.1	16.3	96	85.5	43.6	56	139.0	70.8	15	192.5	98.1	76	246.0	125.3
37	33.0	16.8	97	86.4	44.0	57	139.9	71.3	16	193.4	98.5	77	246.9	125.8
38	33.9	17.2	98	87.3	44.5	58	140.8	71.7	17	194.3	99.0	78	247.8	126.2
39	34.8	17.7	99	88.2	44.9	59	141.7	72.2	18	195.2	99.4	79	248.7	126.7
40	35.7	18.1	100	89.1	45.4	60	142.6	72.6	19	196.1	99.9	80	249.6	127.1
41	36.6	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.5	127.6
42	37.5	19.1	102	90.9	46.3	62	144.3	73.5	22	197.8	100.8	282	251.4	128.0
43	38.4	19.5	103	91.8	46.8	63	145.2	74.0	23	198.7	101.3	283	252.3	128.5
44	39.3	20.0	104	92.7	47.2	64	146.1	74.5	24	199.6	101.7	284	253.2	128.9
45	40.2	20.4	105	93.6	47.7	65	147.0	74.9	25	200.5	102.2	285	254.1	129.4
46	41.1	20.9	106	94.4	48.1	66	147.9	75.4	26	201.4	102.6	286	255.0	129.8
47	42.0	21.3	107	95.3	48.6	67	148.8	75.8	27	202.3	103.1	287	255.9	130.3
48	42.9	21.8	108	96.2	49.0	68	149.7	76.3	28	203.2	103.5	288	256.8	130.7
49	43.8	22.2	109	97.1	49.5	69	150.6	76.7	29	204.1	104.0	289	257.7	131.2
50	44.7	22.7	110	98.0	49.9	70	151.5	77.2	30	205.0	104.4	290	258.6	131.7
51	45.6	23.1	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.5	132.1
52	46.5	23.6	112	99.8	50.8	72	153.3	78.1	32	206.7	105.3	292	260.4	132.6
53	47.4	24.1	113	100.7	51.3	73	154.1	78.5	33	207.6	105.8	293	261.3	133.0
54	48.3	24.5	114	101.6	51.8	74	155.0	79.0	34	208.5	106.2	294	262.2	133.5
55	49.2	25.0	115	102.5	52.2	75	155.9	79.4	35	209.4	106.7	295	263.1	133.9
56	50.1	25.4	116	103.4	52.7	76	156.8	79.9	36	210.3	107.1	296	264.0	134.4
57	51.0	25.9	117	104.3	53.1	77	157.7	80.4	37	211.2	107.6	297	264.9	134.8
58	51.9	26.3	118	105.2	53.6	78	158.6	80.8	38	212.1	108.0	298	265.8	135.3
59	52.8	26.8	119	106.1	54.0	79	159.5	81.3	39	213.0	108.5	299	266.7	135.7
60	53.7	27.2	120	107.0	54.5	80	160.4	81.7	40	213.9	109.0	300	267.6	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 63 Degrees.]

TABLE II.

Difference of Latitude and Departure for 28 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	01.8	00.9	62	54.7	29.1	22	107.7	57.3	82	160.7	85.4	42	213.7	113.6
3	02.6	01.4	63	55.6	29.6	23	108.6	57.7	83	161.6	85.9	43	214.6	114.1
4	03.5	01.9	64	56.5	30.0	24	109.5	58.2	84	162.5	86.4	44	215.4	114.6
5	04.4	02.3	65	57.4	30.5	25	110.4	58.7	85	163.3	86.9	45	216.3	115.0
6	05.3	02.8	66	58.3	31.0	26	111.3	59.2	86	164.2	87.3	46	217.2	115.5
7	06.2	03.3	67	59.2	31.5	27	112.1	59.6	87	165.1	87.8	47	218.1	116.0
8	07.1	03.8	68	60.0	31.9	28	113.0	60.1	88	166.0	88.3	48	219.0	116.4
9	07.9	04.2	69	60.9	32.4	29	113.9	60.6	89	166.9	88.7	49	219.9	116.9
10	08.8	04.7	70	61.8	32.9	30	114.8	61.0	90	167.8	89.2	50	220.7	117.4
11	09.7	05.2	71	62.7	33.3	131	115.7	61.5	191	168.6	89.7	251	221.6	117.8
12	10.6	05.6	72	63.6	33.8	32	116.5	62.0	92	169.5	90.1	52	222.5	118.3
13	11.5	06.1	73	64.5	34.3	33	117.4	62.4	93	170.4	90.6	53	223.4	118.8
14	12.4	06.6	74	65.3	34.7	34	118.3	62.9	94	171.3	91.1	54	224.3	119.2
15	13.2	07.0	75	66.2	35.2	35	119.2	63.4	95	172.2	91.5	55	225.2	119.7
16	14.1	07.5	76	67.1	35.7	36	120.1	63.8	96	173.1	92.0	56	226.0	120.2
17	15.0	08.0	77	68.0	36.1	37	121.0	64.3	97	173.9	92.5	57	226.9	120.7
18	15.9	08.5	78	68.9	36.6	38	121.8	64.8	98	174.8	93.0	58	227.8	121.1
19	16.8	08.9	79	69.8	37.1	39	122.7	65.3	99	175.7	93.4	59	228.7	121.6
20	17.7	09.4	80	70.6	37.6	40	123.6	65.7	200	176.6	93.9	60	229.6	122.1
21	18.5	09.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.4	122.5
22	19.4	10.3	82	72.4	38.5	42	125.4	66.7	02	178.4	94.8	62	231.3	123.0
23	20.3	10.8	83	73.3	39.0	43	126.3	67.1	03	179.2	95.3	63	232.2	123.5
24	21.2	11.3	84	74.2	39.4	44	127.1	67.6	04	180.1	95.8	64	233.1	123.9
25	22.1	11.7	85	75.1	39.9	45	128.0	68.1	05	181.0	96.2	65	234.0	124.4
26	23.0	12.2	86	75.9	40.4	46	128.9	68.5	06	181.9	96.7	66	234.9	124.9
27	23.8	12.7	87	76.8	40.8	47	129.8	69.0	07	182.8	97.2	67	235.7	125.3
28	24.7	13.1	88	77.7	41.3	48	130.7	69.5	08	183.7	97.7	68	236.6	125.8
29	25.6	13.6	89	78.6	41.8	49	131.6	70.0	09	184.6	98.1	69	237.5	126.3
30	26.5	14.1	90	79.5	42.3	50	132.4	70.4	10	185.4	98.6	70	238.4	126.8
31	27.4	14.6	91	80.3	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	52	134.2	71.4	12	187.2	99.5	72	240.2	127.7
33	29.1	15.5	93	82.1	43.7	53	135.1	71.8	13	188.1	100.0	73	241.0	128.2
34	30.0	16.0	94	83.0	44.1	54	136.0	72.3	14	189.0	100.5	74	241.9	128.6
35	30.9	16.4	95	83.9	44.6	55	136.9	72.8	15	189.8	100.9	75	242.8	129.1
36	31.8	16.9	96	84.8	45.1	56	137.7	73.2	16	190.7	101.4	76	243.7	129.6
37	32.7	17.4	97	85.6	45.5	57	138.6	73.7	17	191.6	101.9	77	244.6	130.0
38	33.6	17.8	98	86.5	46.0	58	139.5	74.2	18	192.5	102.3	78	245.5	130.5
39	34.4	18.3	99	87.4	46.5	59	140.4	74.6	19	193.4	102.8	79	246.3	131.0
40	35.3	18.7	100	88.3	46.9	60	141.3	75.1	20	194.2	103.3	80	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	02	90.1	47.9	62	143.0	76.1	22	196.0	104.2	82	249.0	132.4
43	38.0	20.2	03	90.9	48.4	63	143.9	76.5	23	196.9	104.7	83	249.9	132.9
44	38.8	20.7	04	91.8	48.8	64	144.8	77.0	24	197.8	105.2	84	250.8	133.3
45	39.7	21.1	05	92.7	49.3	65	145.7	77.5	25	198.7	105.6	85	251.6	133.8
46	40.6	21.6	06	93.6	49.8	66	146.6	77.9	26	199.5	106.1	86	252.5	134.3
47	41.5	22.1	07	94.5	50.2	67	147.5	78.4	27	200.4	106.6	87	253.4	134.7
48	42.4	22.5	08	95.4	50.7	68	148.3	78.9	28	201.3	107.0	88	254.3	135.2
49	43.3	23.0	09	96.2	51.2	69	149.2	79.3	29	202.2	107.5	89	255.2	135.7
50	44.1	23.5	10	97.1	51.6	70	150.1	79.8	30	203.1	108.0	90	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.4	291	256.9	136.6
52	45.9	24.4	12	98.9	52.6	72	151.9	80.7	32	204.8	108.9	92	257.8	137.1
53	46.8	24.9	13	99.8	53.1	73	152.7	81.2	33	205.7	109.4	93	258.7	137.6
54	47.7	25.4	14	100.7	53.5	74	153.6	81.7	34	206.6	109.9	94	259.6	138.0
55	48.6	25.8	15	101.5	54.0	75	154.5	82.2	35	207.5	110.3	95	260.5	138.5
56	49.4	26.3	16	102.4	54.5	76	155.4	82.6	36	208.4	110.8	96	261.4	139.0
57	50.3	26.8	17	103.3	54.9	77	156.3	83.1	37	209.3	111.3	97	262.2	139.4
58	51.2	27.2	18	104.2	55.4	78	157.2	83.6	38	210.1	111.7	98	263.1	139.9
59	52.1	27.7	19	105.1	55.9	79	158.0	84.0	39	211.0	112.2	99	264.0	140.4
60	53.0	28.2	20	106.0	56.3	80	158.9	84.5	40	211.9	112.7	300	264.9	140.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 62 Degrees.]

Difference of Latitude and Departure for 29 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.4	29.6	121	105.8	58.7	181	158.3	87.8	241	210.8	116.8
2	01.7	01.0	62	54.2	30.1	22	106.7	59.1	82	159.2	88.2	42	211.7	117.3
3	02.6	01.5	63	55.1	30.5	23	107.6	59.6	83	160.1	88.7	43	212.5	117.8
4	03.5	01.9	64	56.0	31.0	24	108.5	60.1	84	160.9	89.2	44	213.4	118.3
5	04.4	02.4	65	56.9	31.5	25	109.3	60.6	85	161.8	89.7	45	214.3	118.8
6	05.2	02.9	66	57.7	32.0	26	110.2	61.1	86	162.7	90.2	46	215.2	119.3
7	06.1	03.4	67	58.6	32.5	27	111.1	61.6	87	163.6	90.7	47	216.0	119.7
8	07.0	03.9	68	59.5	33.0	28	112.0	62.1	88	164.4	91.1	48	216.9	120.2
9	07.9	04.4	69	60.3	33.5	29	112.8	62.5	89	165.3	91.6	49	217.8	120.7
10	08.7	04.8	70	61.2	33.9	30	113.7	63.0	90	166.2	92.1	50	218.7	121.2
11	09.6	05.3	71	62.1	34.4	131	114.6	63.5	191	167.1	92.6	251	219.5	121.7
12	10.5	05.8	72	63.0	34.9	32	115.4	64.0	92	167.9	93.1	52	220.4	122.2
13	11.4	06.3	73	63.8	35.4	33	116.3	64.5	93	168.8	93.6	53	221.3	122.7
14	12.2	06.8	74	64.7	35.9	34	117.2	65.0	94	169.7	94.1	54	222.2	123.1
15	13.1	07.3	75	65.6	36.4	35	118.1	65.4	95	170.6	94.5	55	223.0	123.6
16	14.0	07.8	76	66.5	36.8	36	118.9	65.9	96	171.4	95.0	56	223.9	124.1
17	14.9	08.2	77	67.3	37.3	37	119.8	66.4	97	172.3	95.5	57	224.8	124.6
18	15.7	08.7	78	68.2	37.8	38	120.7	66.9	98	173.2	96.0	58	225.7	125.1
19	16.6	09.2	79	69.1	38.3	39	121.6	67.4	99	174.0	96.5	59	226.5	125.6
20	17.5	09.7	80	70.0	38.8	40	122.4	67.9	200	174.9	97.0	60	227.4	126.1
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	42	124.2	68.8	02	176.7	97.9	62	229.2	127.0
23	20.1	11.2	83	72.6	40.2	43	125.1	69.3	03	177.5	98.4	63	230.0	127.5
24	21.0	11.6	84	73.5	40.7	44	125.9	69.8	04	178.4	98.9	64	230.9	128.0
25	21.9	12.1	85	74.3	41.2	45	126.8	70.3	05	179.3	99.4	65	231.8	128.5
26	22.7	12.6	86	75.2	41.7	46	127.7	70.8	06	180.2	99.9	66	232.6	129.0
27	23.6	13.1	87	76.1	42.2	47	128.6	71.3	07	181.0	100.4	67	233.5	129.4
28	24.5	13.6	88	77.0	42.7	48	129.4	71.8	08	181.9	100.8	68	234.4	129.9
29	25.4	14.1	89	77.8	43.1	49	130.3	72.2	09	182.8	101.3	69	235.3	130.4
30	26.2	14.5	90	78.7	43.6	50	131.2	72.7	10	183.7	101.8	70	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	52	132.9	73.7	12	185.4	102.8	72	237.9	131.9
33	28.9	16.0	93	81.3	45.1	53	133.8	74.2	13	186.3	103.3	73	238.8	132.4
34	29.7	16.5	94	82.2	45.6	54	134.7	74.7	14	187.2	103.7	74	239.6	132.8
35	30.6	17.0	95	83.1	46.1	55	135.6	75.1	15	188.0	104.2	75	240.5	133.3
36	31.5	17.5	96	84.0	46.5	56	136.4	75.6	16	188.9	104.7	76	241.4	133.8
37	32.4	17.9	97	84.8	47.0	57	137.3	76.1	17	189.8	105.2	77	242.3	134.3
38	33.2	18.4	98	85.7	47.5	58	138.2	76.6	18	190.7	105.7	78	243.1	134.8
39	34.1	18.9	99	86.6	48.0	59	139.1	77.1	19	191.5	106.2	79	244.0	135.3
40	35.0	19.4	100	87.5	48.5	60	139.9	77.6	20	192.4	106.7	80	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	02	89.2	49.5	62	141.7	78.5	22	194.2	107.6	82	246.6	136.7
43	37.6	20.8	03	90.1	49.9	63	142.6	79.0	23	195.0	108.1	83	247.5	137.2
44	38.5	21.3	04	91.0	50.4	64	143.4	79.5	24	195.9	108.6	84	248.4	137.7
45	39.4	21.8	05	91.8	50.9	65	144.3	80.0	25	196.8	109.1	85	249.3	138.2
46	40.2	22.3	06	92.7	51.4	66	145.2	80.5	26	197.7	109.6	86	250.1	138.7
47	41.1	22.8	07	93.6	51.9	67	146.1	81.0	27	198.5	110.1	87	251.0	139.1
48	42.0	23.3	08	94.5	52.4	68	146.9	81.4	28	199.4	110.5	88	251.9	139.6
49	42.9	23.8	09	95.3	52.8	69	147.8	81.9	29	200.3	111.0	89	252.8	140.1
50	43.7	24.2	10	96.2	53.3	70	148.7	82.4	30	201.2	111.5	90	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	12	98.0	54.3	72	150.4	83.4	32	202.9	112.5	92	255.4	141.6
53	46.4	25.7	13	98.8	54.8	73	151.3	83.9	33	203.8	113.0	93	256.3	142.0
54	47.2	26.2	14	99.7	55.3	74	152.2	84.4	34	204.7	113.4	94	257.1	142.5
55	48.1	26.7	15	100.6	55.8	75	153.1	84.8	35	205.5	113.9	95	258.0	143.0
56	49.0	27.1	16	101.5	56.2	76	153.9	85.3	36	206.4	114.4	96	258.9	143.5
57	49.9	27.6	17	102.3	56.7	77	154.8	85.8	37	207.3	114.9	97	259.8	144.0
58	50.7	28.1	18	103.2	57.2	78	155.7	86.3	38	208.2	115.4	98	260.6	144.5
59	51.6	28.6	19	104.1	57.7	79	156.6	86.8	39	209.0	115.9	99	261.5	145.0
60	52.5	29.1	20	105.0	58.2	80	157.4	87.3	40	209.9	116.4	300	262.4	145.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 61 Degrees.]

TABLE II.

Difference of Latitude and Departure for 30 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00 5	61	52 8	30 5	121	104 8	60 5	181	156 8	90 5	241	208 7	120 5
2	01 7	01 0	62	53 7	31 0	122	105 7	61 0	182	157 6	91 0	242	209 6	121 0
3	02 6	01 5	63	54 6	31 5	123	106 5	61 5	183	158 5	91 5	243	210 4	121 5
4	03 5	02 0	64	55 4	32 0	124	107 4	62 0	184	159 3	92 0	244	211 3	122 0
5	04 3	02 5	65	56 3	32 5	125	108 3	62 5	185	160 2	92 5	245	212 2	122 5
6	05 2	03 0	66	57 2	33 0	126	109 1	63 0	186	161 1	93 0	246	213 0	123 0
7	06 1	03 5	67	58 0	33 5	127	110 0	63 5	187	161 9	93 5	247	213 9	123 5
8	06 9	04 0	68	58 9	34 0	128	110 9	64 0	188	162 8	94 0	248	214 8	124 0
9	07 8	04 5	69	59 8	34 5	129	111 7	64 5	189	163 7	94 5	249	215 6	124 5
10	08 7	05 0	70	60 6	35 0	130	112 6	65 0	190	164 5	95 0	250	216 5	125 0
11	09 5	05 5	71	61 5	35 5	131	113 4	65 5	191	165 4	95 5	251	217 4	125 5
12	10 4	06 0	72	62 4	36 0	132	114 3	66 0	192	166 3	96 0	252	218 2	126 0
13	11 3	06 5	73	63 2	36 5	133	115 2	66 5	193	167 1	96 5	253	219 1	126 5
14	12 1	07 0	74	64 1	37 0	134	116 0	67 0	194	168 0	97 0	254	220 0	127 0
15	13 0	07 5	75	65 0	37 5	135	116 9	67 5	195	168 9	97 5	255	220 8	127 5
16	13 9	08 0	76	65 8	38 0	136	117 8	68 0	196	169 7	98 0	256	221 7	128 0
17	14 7	08 5	77	66 7	38 5	137	118 6	68 5	197	170 6	98 5	257	222 6	128 5
18	15 6	09 0	78	67 5	39 0	138	119 5	69 0	198	171 5	99 0	258	223 4	129 0
19	16 5	09 5	79	68 4	39 5	139	120 4	69 5	199	172 3	99 5	259	224 3	129 5
20	17 3	10 0	80	69 3	40 0	140	121 2	70 0	200	173 2	100 0	260	225 2	130 0
21	18 2	10 5	81	70 1	40 5	141	122 1	70 5	201	174 1	100 5	261	226 0	130 5
22	19 1	11 0	82	71 0	41 0	142	123 0	71 0	202	174 9	101 0	262	226 9	131 0
23	19 9	11 5	83	71 9	41 5	143	123 8	71 5	203	175 8	101 5	263	227 8	131 5
24	20 8	12 0	84	72 7	42 0	144	124 7	72 0	204	176 7	102 0	264	228 6	132 0
25	21 7	12 5	85	73 6	42 5	145	125 6	72 5	205	177 5	102 5	265	229 5	132 5
26	22 5	13 0	86	74 5	43 0	146	126 4	73 0	206	178 4	103 0	266	230 4	133 0
27	23 4	13 5	87	75 3	43 5	147	127 3	73 5	207	179 3	103 5	267	231 3	133 5
28	24 2	14 0	88	76 2	44 0	148	128 2	74 0	208	180 1	104 0	268	232 1	134 0
29	25 1	14 5	89	77 1	44 5	149	129 0	74 5	209	181 0	104 5	269	233 0	134 5
30	26 0	15 0	90	77 9	45 0	150	129 9	75 0	210	181 9	105 0	270	234 0	135 0
31	26 8	15 5	91	78 8	45 5	151	130 8	75 5	211	182 7	105 5	271	234 7	135 5
32	27 7	16 0	92	79 7	46 0	152	131 6	76 0	212	183 6	106 0	272	235 6	136 0
33	28 6	16 5	93	80 5	46 5	153	132 5	76 5	213	184 5	106 5	273	236 4	136 5
34	29 4	17 0	94	81 4	47 0	154	133 4	77 0	214	185 3	107 0	274	237 3	137 0
35	30 3	17 5	95	82 3	47 5	155	134 2	77 5	215	186 2	107 5	275	238 2	137 5
36	31 2	18 0	96	83 1	48 0	156	135 1	78 0	216	187 1	108 0	276	239 0	138 0
37	32 0	18 5	97	84 0	48 5	157	136 0	78 5	217	187 9	108 5	277	239 9	138 5
38	32 9	19 0	98	84 9	49 0	158	136 8	79 0	218	188 8	109 0	278	240 8	139 0
39	33 8	19 5	99	85 7	49 5	159	137 7	79 5	219	189 7	109 5	279	241 6	139 5
40	34 6	20 0	100	86 6	50 0	160	138 6	80 0	220	190 5	110 0	280	242 5	140 0
41	35 5	20 5	101	87 5	50 5	161	139 4	80 5	221	191 4	110 5	281	243 4	140 5
42	36 4	21 0	102	88 3	51 0	162	140 3	81 0	222	192 3	111 0	282	244 2	141 0
43	37 2	21 5	103	89 2	51 5	163	141 2	81 5	223	193 1	111 5	283	245 1	141 5
44	38 1	22 0	104	90 1	52 0	164	142 0	82 0	224	194 0	112 0	284	246 0	142 0
45	39 0	22 5	105	90 9	52 5	165	142 9	82 5	225	194 9	112 5	285	246 9	142 5
46	39 8	23 0	106	91 8	53 0	166	143 8	83 0	226	195 7	113 0	286	247 7	143 0
47	40 7	23 5	107	92 7	53 5	167	144 6	83 5	227	196 6	113 5	287	248 6	143 5
48	41 6	24 0	108	93 5	54 0	168	145 5	84 0	228	197 5	114 0	288	249 4	144 0
49	42 4	24 5	109	94 4	54 5	169	146 4	84 5	229	198 3	114 5	289	250 3	144 5
50	43 3	25 0	110	95 3	55 0	170	147 2	85 0	230	199 2	115 0	290	251 1	145 0
51	44 2	25 5	111	96 1	55 5	171	148 1	85 5	231	200 1	115 5	291	252 0	145 5
52	45 0	26 0	112	97 0	56 0	172	149 0	86 0	232	200 9	116 0	292	252 9	146 0
53	45 9	26 5	113	97 9	56 5	173	149 8	86 5	233	201 8	116 5	293	253 7	146 5
54	46 8	27 0	114	98 7	57 0	174	150 7	87 0	234	202 6	117 0	294	254 6	147 0
55	47 6	27 5	115	99 6	57 5	175	151 6	87 5	235	203 5	117 5	295	255 5	147 5
56	48 5	28 0	116	100 5	58 0	176	152 4	88 0	236	204 4	118 0	296	256 4	148 0
57	49 4	28 5	117	101 3	58 5	177	153 3	88 5	237	205 3	118 5	297	257 3	148 5
58	50 2	29 0	118	102 2	59 0	178	154 2	89 0	238	206 1	119 0	298	258 1	149 0
59	51 1	29 5	119	103 1	59 5	179	155 0	89 5	239	207 0	119 5	299	259 0	149 5
60	52 0	30 0	120	103 9	60 0	180	155 9	90 0	240	207 8	120 0	300	259 8	150 0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 60 Degrees.)

TABLE II.

Difference of Latitude and Departure for 31 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 9	00.5	61	52 3	31.4	121	103.7	62.3	181	155 1	93.2	241	206 6	124.1
2	01 7	01.0	62	53.1	31.9	122	104.6	62.8	82	156 0	93.7	42	207 4	124.6
3	02 6	01.5	63	54 0	32.4	123	105.4	63.3	83	156 9	94.3	43	208.3	125.2
4	03 4	02.1	64	54.9	33.0	124	106.3	63.9	84	157 7	94.8	44	209.1	125.7
5	04.3	02.6	65	55 7	33.5	125	107.1	64.4	85	158.6	95.3	45	210.0	126.2
6	05.1	03.1	66	56 6	34.0	126	108 0	64.9	86	159.4	95.8	46	210 9	126.7
7	06 0	03.6	67	57.4	34.5	127	108 9	65.4	87	160.3	96.3	47	211.7	127.2
8	06 9	04.1	68	58 3	35.0	128	109 7	65.9	88	161.1	96.8	48	212 6	127.7
9	07 7	04.6	69	59.1	35.5	129	110 6	66.4	89	162 0	97.3	49	213 4	128.2
10	08 6	05.2	70	60 0	36.1	130	111.4	67.0	90	162 9	97.9	50	214.3	128.8
11	09 4	05.7	71	60 9	36.6	131	112 3	67.5	191	163 7	98.4	251	215 1	129.3
12	10 3	06.2	72	61 7	37.1	132	113 1	68.0	92	164 6	98.9	52	216 0	129.8
13	11 1	06.7	73	62 6	37.6	133	114 0	68.5	93	165.4	99.4	53	216 9	130.3
14	12 0	07.2	74	63 4	38.1	134	114 9	69.0	94	166.3	99.9	54	217 7	130.8
15	12 9	07.7	75	64 3	38.6	135	115.7	69.5	95	167.1	100.4	55	218 6	131.3
16	13 7	08.2	76	65 1	39.1	136	116.6	70.0	96	168 0	100.9	56	219.4	131.8
17	14 6	08.8	77	66 0	39.7	137	117.4	70.6	97	168 9	101.5	57	220 3	132.4
18	15.4	09.3	78	66 9	40.2	138	118.3	71.1	98	169 7	102.0	58	221 1	132.9
19	16.3	09.8	79	67 7	40.7	139	119.1	71.6	99	170 6	102.5	59	222.0	133.4
20	17 1	10.3	80	68 6	41.2	140	120 0	72.1	200	171.4	103.0	60	222 9	133.9
21	18.0	10.8	81	69.4	41.7	141	120 9	72.6	201	172 3	103.5	261	223.7	134.4
22	18.9	11.3	82	70 3	42.2	142	121.7	73.1	173	173 1	104.0	62	224 6	134.9
23	19 7	11.8	83	71.1	42.7	143	122 6	73.7	03	174.0	104.6	63	225 4	135.5
24	20 6	12.4	84	72.0	43.3	144	123 4	74.2	04	174 9	105.1	64	226.3	136.0
25	21 4	12.9	85	72 9	43.8	145	124 3	74.7	05	175.7	105.6	65	227 1	136.5
26	22 3	13.4	86	73 7	44.3	146	125.1	75.2	06	176.6	106.1	66	228.0	137.0
27	23.1	13.9	87	74.6	44.8	147	126.0	75.7	07	177 4	106.6	67	228 9	137.5
28	24.0	14.4	88	75 4	45.3	148	126 9	76.2	08	178 3	107.1	68	229.7	138.0
29	24 9	14.9	89	76 3	45.8	149	127.7	76.7	09	179 1	107.6	69	230 6	138.5
30	25 7	15.5	90	77.1	46.4	150	128 6	77.3	10	180 0	108.2	70	231 4	139.1
31	26 6	16.0	91	78 0	46.9	151	129 4	77.8	211	180.9	108.7	71	232 3	139.6
32	27 4	16.5	92	78 9	47.4	152	130.3	78.3	181	181 7	109.2	72	233.1	140.1
33	28 3	17.0	93	79 7	47.9	153	131.1	78.8	13	182 6	109.7	73	234 0	140.6
34	29 1	17.5	94	80 6	48.4	154	132.0	79.3	14	183 4	110.2	74	234 9	141.1
35	30 0	18.0	95	81 4	48.9	155	132 9	79.8	15	184.3	110.7	75	235 7	141.6
36	30 9	18.5	96	82 3	49.4	156	133.7	80.3	16	185.1	111.2	76	236 6	142.2
37	31 7	19.1	97	83 1	50.0	157	134.6	80.9	17	186.0	111.8	77	237 4	142.7
38	32.6	19.6	98	84.0	50.5	158	135.4	81.4	18	186 9	112.3	78	238.3	143.2
39	33.4	20.1	99	84.9	51.0	159	136.3	81.9	19	187 7	112.8	79	239.1	143.7
40	34 3	20.6	100	85 7	51.5	160	137.1	82.4	20	188.6	113.3	80	240 0	144.2
41	35.1	21.1	101	86 6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.9	144.7
42	36.0	21.6	02	87 4	52.5	162	138 9	83.4	22	190.3	114.3	82	241 7	145.2
43	36 9	22.1	03	88.3	53.0	163	139 7	84.0	23	191.1	114.9	83	242 6	145.8
44	37 7	22.7	04	89 1	53.6	164	140 6	84.5	24	192 0	115.4	84	243 4	146.3
45	38.6	23.2	05	90 0	54.1	165	141.4	85.0	25	192.9	115.9	85	244 3	146.8
46	39.4	23.7	06	90 9	54.6	166	142 3	85.5	26	193 7	116.4	86	245 1	147.3
47	40.3	24.2	07	91 7	55.1	167	143 1	86.0	27	194 6	116.9	87	246 0	147.8
48	41.1	24.7	08	92 6	55.6	168	144 0	86.5	28	195 4	117.4	88	246.9	148.3
49	42.0	25.2	09	93 4	56.1	169	144 9	87.0	29	196.3	117.9	89	247.7	148.8
50	42 9	25.8	10	94.3	56.7	170	145 7	87.6	30	197 1	118.5	90	248.6	149.4
51	43 7	26.3	111	95 1	57.2	171	146 6	88.1	231	198 0	119.0	291	249.4	149.9
52	44 6	26.8	12	96.0	57.7	172	147 4	88.6	32	198 9	119.5	81	250.3	150.4
53	45 4	27.3	13	96.9	58.2	173	148.3	89.1	33	199 7	120.0	93	251.2	150.9
54	46.3	27.8	14	97.7	58.7	174	149.1	89.6	34	200.6	120.5	94	252.0	151.4
55	47 1	28.3	15	98 6	59.2	175	150.0	90.1	35	201 4	121.0	95	252 9	151.9
56	48 0	28.8	16	99 4	59.7	176	150.9	90.6	36	202.3	121.5	96	253.7	152.5
57	48 9	29.4	17	100 3	60.3	177	151.7	91.2	37	203 1	122.1	97	254 6	153.0
58	49.7	29.9	18	101 1	60.8	178	152 6	91.7	38	204 0	122.6	98	255 4	153.5
59	50 6	30.4	19	102 0	61.3	179	153 4	92.2	39	204 9	123.1	99	256 3	154.0
60	51 4	30.9	20	102 9	61.8	180	154.3	92.7	40	205.7	123.6	300	257.1	154.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 59 Degrees.)

TABLE II.

Difference of Latitude and Departure for 32 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 3	00 5	61	51 7	32 5	121	102 6	64 1	181	153 5	95 9	241	204 4	127 7
2	01 7	01 1	62	52 6	32 9	122	103 5	64 7	182	154 3	96 4	242	205 2	128 2
3	02 5	01 6	63	53 4	33 4	123	104 3	65 2	183	155 2	97 0	243	206 1	128 8
4	03 4	02 1	64	54 3	33 9	124	105 2	65 7	184	156 0	97 5	244	206 9	129 3
5	04 2	02 6	65	55 1	34 4	125	106 0	66 2	185	156 9	98 0	245	207 8	129 8
6	05 1	03 2	66	56 0	35 0	126	106 9	66 8	186	157 7	98 6	246	208 6	130 4
7	05 9	03 7	67	56 8	35 5	127	107 7	67 3	187	158 6	99 1	247	209 5	130 9
8	06 8	04 2	68	57 7	36 0	128	108 6	67 8	188	159 4	99 6	248	210 3	131 4
9	07 6	04 8	69	58 5	36 6	129	109 4	68 4	189	160 3	100 2	249	211 2	131 9
10	08 5	05 3	70	59 4	37 1	130	110 2	68 9	190	161 1	100 7	250	212 0	132 5
11	09 3	05 8	71	60 2	37 6	131	111 1	69 4	191	162 0	101 2	251	212 9	133 0
12	10 2	06 4	72	61 1	38 2	132	111 9	69 9	192	162 8	101 7	252	213 7	133 5
13	11 0	06 9	73	61 9	38 7	133	112 8	70 5	193	163 7	102 3	253	214 6	134 1
14	11 9	07 4	74	62 8	39 2	134	113 6	71 0	194	164 5	102 8	254	215 4	134 6
15	12 7	07 9	75	63 6	39 7	135	114 5	71 5	195	165 4	103 3	255	216 3	135 1
16	13 6	08 5	76	64 5	40 3	136	115 3	72 1	196	166 2	103 9	256	217 1	135 7
17	14 4	09 0	77	65 3	40 8	137	116 2	72 6	197	167 1	104 4	257	217 9	136 2
18	15 3	09 5	78	66 1	41 3	138	117 0	73 1	198	167 9	104 9	258	218 8	136 7
19	16 1	10 1	79	67 0	41 9	139	117 9	73 7	199	168 8	105 5	259	219 6	137 2
20	17 0	10 6	80	67 8	42 4	140	118 7	74 2	200	169 6	106 0	260	220 5	137 8
21	17 8	11 1	81	68 7	42 9	141	119 6	74 7	201	170 5	106 5	261	221 3	138 3
22	18 7	11 7	82	69 5	43 5	142	120 4	75 2	202	171 3	107 0	262	222 2	138 8
23	19 5	12 2	83	70 4	44 0	143	121 3	75 8	203	172 2	107 6	263	223 0	139 4
24	20 4	12 7	84	71 2	44 5	144	122 1	76 3	204	173 0	108 1	264	223 9	139 9
25	21 2	13 2	85	72 1	45 0	145	123 0	76 8	205	173 8	108 6	265	224 7	140 4
26	22 0	13 6	86	72 9	45 6	146	123 8	77 4	206	174 7	109 2	266	225 6	141 0
27	22 9	14 3	87	73 8	46 1	147	124 7	77 9	207	175 5	109 7	267	226 4	141 5
28	23 7	14 8	88	74 6	46 6	148	125 5	78 4	208	176 4	110 2	268	227 3	142 0
29	24 6	15 4	89	75 5	47 2	149	126 4	79 0	209	177 2	110 8	269	228 1	142 5
30	25 4	15 9	90	76 3	47 7	150	127 2	79 5	210	178 1	111 3	270	229 0	143 1
31	26 3	16 4	91	77 2	48 2	151	128 1	80 0	211	178 9	111 8	271	229 8	143 6
32	27 1	17 0	92	78 0	48 8	152	128 9	80 5	212	179 8	112 3	272	230 7	144 1
33	28 0	17 5	93	78 9	49 3	153	129 8	81 1	213	180 6	112 9	273	231 5	144 7
34	28 8	18 0	94	79 7	49 8	154	130 6	81 6	214	181 5	113 4	274	232 4	145 2
35	29 7	18 5	95	80 6	50 3	155	131 4	82 1	215	182 3	113 9	275	233 2	145 7
36	30 5	19 1	96	81 4	50 9	156	132 3	82 7	216	183 2	114 5	276	234 1	146 3
37	31 4	19 6	97	82 3	51 4	157	133 1	83 2	217	184 0	115 0	277	234 9	146 8
38	32 2	20 1	98	83 1	51 9	158	134 0	83 7	218	184 9	115 5	278	235 8	147 3
39	33 1	20 7	99	84 0	52 5	159	134 8	84 3	219	185 7	116 1	279	236 6	147 8
40	33 9	21 2	100	84 8	53 0	160	135 7	84 8	220	186 6	116 6	280	237 5	148 4
41	34 8	21 7	101	85 7	53 5	161	136 5	85 3	221	187 4	117 1	281	238 3	148 9
42	35 6	22 3	102	86 5	54 1	162	137 4	85 8	222	188 3	117 6	282	239 1	149 4
43	36 5	22 8	103	87 3	54 6	163	138 2	86 4	223	189 1	118 2	283	240 0	150 0
44	37 3	23 3	104	88 2	55 1	164	139 1	86 9	224	190 0	118 7	284	240 8	150 5
45	38 2	23 8	105	89 0	55 6	165	139 9	87 4	225	190 8	119 2	285	241 7	151 0
46	39 0	24 4	106	89 9	56 2	166	140 8	88 0	226	191 7	119 8	286	242 5	151 6
47	39 9	24 9	107	90 7	56 7	167	141 6	88 5	227	192 5	120 3	287	243 4	152 1
48	40 7	25 4	108	91 6	57 2	168	142 5	89 0	228	193 4	120 8	288	244 2	152 6
49	41 6	26 0	109	92 4	57 8	169	143 3	89 6	229	194 2	121 4	289	245 1	153 1
50	42 4	26 5	110	93 3	58 3	170	144 2	90 1	230	195 1	121 9	290	245 9	153 7
51	43 3	27 0	111	94 1	58 8	171	145 0	90 6	231	195 9	122 4	291	246 8	154 2
52	44 1	27 6	112	95 0	59 4	172	145 9	91 1	232	196 7	122 9	292	247 6	154 7
53	44 9	28 1	113	95 8	59 9	173	146 7	91 7	233	197 6	123 5	293	248 5	155 3
54	45 8	28 6	114	96 7	60 4	174	147 6	92 2	234	198 4	124 0	294	249 3	155 8
55	46 6	29 1	115	97 5	60 9	175	148 4	92 7	235	199 3	124 5	295	250 2	156 3
56	47 5	29 7	116	98 4	61 5	176	149 3	93 3	236	200 1	125 1	296	251 0	156 9
57	48 3	30 2	117	99 2	62 0	177	150 1	93 8	237	201 0	125 6	297	251 9	157 4
58	49 2	30 7	118	100 1	62 5	178	151 0	94 3	238	201 8	126 1	298	252 7	157 9
59	50 0	31 3	119	100 9	63 1	179	151 8	94 9	239	202 7	126 7	299	253 6	158 4
60	50 9	31 8	120	101 8	63 6	180	152 6	95 4	240	203 5	127 2	300	254 4	159 0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 32 Degrees.]

TABLE H.

49

Difference of Latitude and Departure for 33 Degrees.

Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1 00 8	00 5	51	51 2	33 2	121	101 5	67 0	181	151 8	98 6	241	201 1	131 3
2 01 7	01 1	62	52 0	33 8	22	102 3	67 1	82	152 6	99 1	42	203 0	131 8
3 02 5	01 6	65	52 8	34 3	33	103 2	67 0	83	153 5	99 7	53	203 8	132 3
4 03 4	02 3	64	53 7	34 9	44	104 0	67 5	84	154 3	100 2	64	204 6	132 9
5 04 2	02 7	65	54 5	35 4	55	105 0	68 1	85	155 2	100 8	75	205 5	133 4
6 05 0	03 3	66	55 4	35 9	66	105 7	68 6	86	156 0	101 3	86	206 3	134 0
7 05 9	03 8	67	56 2	36 5	77	106 5	69 2	87	156 8	101 8	97	207 2	134 5
8 06 7	04 4	68	57 0	37 0	88	107 3	69 7	88	157 7	102 4	108	208 1	135 1
9 07 5	04 9	69	57 9	37 6	99	108 2	70 3	89	158 5	102 9	119	208 8	135 6
10 08 4	05 4	70	58 7	38 1	110	109 0	70 8	90	159 3	103 5	130	209 7	136 2
11 09 2	06 0	71	59 5	38 7	121	109 9	71 3	191	160 2	104 0	251	210 5	136 7
12 10 1	06 5	72	60 4	39 2	32	110 7	71 9	92	161 0	104 6	52	211 3	137 2
13 10 9	07 1	73	61 2	39 8	43	111 5	72 4	93	161 9	105 1	53	212 1	137 7
14 11 7	07 6	74	62 1	40 3	54	112 4	73 0	94	162 7	105 7	64	213 0	138 3
15 12 6	08 2	75	62 9	40 8	65	113 2	73 5	95	163 5	106 2	75	213 9	138 9
16 13 4	08 7	76	63 7	41 4	76	114 1	74 1	96	164 4	106 7	86	214 7	139 4
17 14 3	09 3	77	64 6	41 9	87	114 9	74 6	97	165 2	107 3	97	215 5	140 0
18 15 1	09 8	78	65 4	42 5	98	115 7	75 2	98	166 1	107 8	108	216 4	140 5
19 15 9	10 3	79	66 3	43 0	109	116 6	75 7	99	166 9	108 4	119	217 2	141 1
20 16 8	10 9	80	67 1	43 6	120	117 4	76 2	200	167 7	108 9	130	218 1	141 6
21 17 6	11 4	81	67 9	44 1	131	118 3	76 8	201	168 6	109 5	261	218 9	142 2
22 18 5	12 0	82	68 8	44 7	42	119 1	77 3	02	169 4	110 0	62	219 7	142 7
23 19 3	12 5	83	69 6	45 2	53	119 9	77 9	03	170 3	110 6	63	220 6	143 2
24 20 2	13 1	84	70 4	45 7	64	120 8	78 4	04	171 1	111 1	74	221 4	143 8
25 21 0	13 6	85	71 3	46 3	75	121 6	79 0	05	171 9	111 7	85	222 2	144 3
26 21 8	14 2	86	72 1	46 8	86	122 4	79 5	06	172 8	112 2	96	223 1	144 9
27 22 6	14 7	87	73 0	47 4	97	123 3	80 1	07	173 6	112 7	107	223 9	145 4
28 23 5	15 2	88	73 8	47 9	108	124 1	80 6	08	174 4	113 3	118	224 8	146 0
29 24 3	15 8	89	74 6	48 5	119	125 0	81 2	09	175 3	113 8	129	225 6	146 5
30 25 2	16 3	90	75 5	49 0	130	125 8	81 7	10	176 1	114 4	140	226 4	147 1
31 26 0	16 9	91	76 3	49 6	141	126 6	82 2	211	177 0	114 9	271	227 3	147 6
32 26 8	17 4	92	77 2	50 1	52	127 5	82 8	12	177 8	115 5	72	228 1	148 1
33 27 7	18 0	93	78 0	50 7	63	128 3	83 3	13	178 6	116 0	83	229 0	148 7
34 28 5	18 5	94	78 8	51 2	74	129 2	83 9	14	179 5	116 6	94	229 8	149 2
35 29 4	19 1	95	79 7	51 7	85	130 0	84 4	15	180 3	117 1	105	230 6	149 8
36 30 2	19 6	96	80 5	52 3	96	130 8	85 0	16	181 2	117 6	116	231 5	150 3
37 31 0	20 2	97	81 4	52 8	107	131 7	85 5	17	182 0	118 2	127	232 3	150 9
38 31 9	20 7	98	82 2	53 4	118	132 5	86 1	18	182 8	118 7	138	233 2	151 4
39 32 7	21 2	99	83 1	53 9	129	133 4	86 6	19	183 7	119 3	149	234 0	152 0
40 33 5	21 8	100	84 0	54 5	140	134 2	87 1	20	184 5	119 8	160	234 8	152 5
41 34 4	22 3	101	84 7	55 0	151	135 0	87 7	211	185 3	120 4	281	235 7	153 0
42 35 2	22 9	02	85 5	55 6	62	135 9	88 2	22	186 2	120 9	82	236 5	153 6
43 36 1	23 4	03	86 4	56 1	73	136 7	88 8	23	187 0	121 5	93	237 3	154 1
44 36 9	24 0	04	87 2	56 6	84	137 5	89 3	24	187 9	122 0	104	238 2	154 7
45 37 7	24 5	05	88 1	57 2	95	138 4	89 9	25	188 7	122 5	115	239 0	155 2
46 38 6	25 1	06	88 9	57 7	106	139 2	90 4	26	189 5	123 1	126	239 9	155 8
47 39 4	25 6	07	89 7	58 3	117	140 1	91 0	27	190 4	123 6	137	240 7	156 3
48 40 3	26 1	08	90 6	58 8	128	140 9	91 5	28	191 2	124 2	148	241 6	156 9
49 41 1	26 7	09	91 4	59 4	139	141 7	92 0	29	192 1	124 7	159	242 4	157 4
50 41 9	27 2	10	92 3	59 9	150	142 6	92 6	30	192 9	125 3	170	243 3	157 9
51 42 8	27 8	111	93 1	60 5	161	143 4	93 1	231	193 7	125 8	291	244 1	158 5
52 43 6	28 3	12	93 9	61 0	72	144 3	93 7	32	194 6	126 4	92	244 9	159 0
53 44 4	28 9	13	94 8	61 5	83	145 1	94 2	33	195 4	126 9	103	245 7	159 6
54 45 3	29 4	14	95 6	62 1	94	145 9	94 8	34	196 3	127 4	114	246 6	160 1
55 46 1	30 0	15	96 4	62 6	105	146 8	95 3	35	197 1	128 0	125	247 4	160 7
56 47 0	30 5	16	97 3	63 2	116	147 6	95 9	36	197 9	128 5	136	248 3	161 2
57 47 8	31 0	17	98 1	63 7	127	148 5	96 4	37	198 8	129 1	147	249 1	161 8
58 48 6	31 6	18	99 0	64 3	138	149 3	96 9	38	199 6	129 6	158	249 9	162 3
59 49 5	32 1	19	99 8	64 8	149	150 1	97 5	39	200 4	130 2	169	250 8	162 8
60 50 3	32 7	20	100 6	65 4	160	151 0	98 0	40	201 3	130 7	180	251 6	163 4
Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 57 Degrees.)

TABLE II.

Difference of Latitude and Departure for 34 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	02.5	01.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.5	135.9
4	03.3	02.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	04.1	02.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	05.0	03.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	05.8	03.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	06.6	04.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	07.5	05.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	08.3	05.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	07.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	07.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	08.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	08.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	09.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	39	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.6	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	170.0	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.6	47	121.9	82.2	07	171.6	115.8	67	221.4	149.3
28	23.2	15.7	88	73.0	49.2	48	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.8	118.5	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.2	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.2	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.5	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.9	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.3	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.7	132.0	96	245.4	165.5
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.1	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	20	99.5	67.1	80	149.2	100.7	40	199.0	134.2	300	248.7	167.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 56 Degrees.]

TABLE II.

51

Difference of Latitude and Departure for 35 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.8	35.0	121	99.1	69.4	181	148.3	103.8	241	197.4	138.2
2	01.6	01.1	62	50.8	35.6	122	99.9	70.0	182	149.1	104.4	242	198.2	138.8
3	02.3	01.7	63	51.6	36.1	123	100.8	70.6	183	149.9	105.0	243	199.1	139.4
4	03.3	02.3	64	52.4	36.7	124	101.6	71.1	184	150.7	105.6	244	199.9	140.0
5	04.1	02.9	65	53.2	37.3	125	102.4	71.7	185	151.5	106.1	245	200.7	140.5
6	04.9	03.4	66	54.1	37.9	126	103.2	72.3	186	152.4	106.7	246	201.5	141.1
7	05.7	04.0	67	54.9	38.4	127	104.0	72.8	187	153.2	107.3	247	202.3	141.7
8	06.6	04.6	68	55.7	39.0	128	104.9	73.4	188	154.0	107.8	248	203.1	142.2
9	07.4	05.2	69	56.5	39.6	129	105.7	74.0	189	154.8	108.4	249	204.0	142.8
10	08.2	05.7	70	57.3	40.2	130	106.5	74.6	190	155.6	109.0	250	204.8	143.4
11	09.0	06.3	71	58.2	40.7	131	107.3	75.1	191	156.5	109.6	251	205.6	144.0
12	09.8	06.9	72	59.0	41.3	132	108.1	75.7	192	157.3	110.1	252	206.4	144.5
13	10.6	07.5	73	59.7	41.9	133	108.9	76.3	193	158.1	110.7	253	207.2	145.1
14	11.5	08.0	74	60.6	42.4	134	109.8	76.9	194	158.9	111.3	254	208.1	145.7
15	12.3	08.6	75	61.4	43.0	135	110.6	77.4	195	159.7	111.8	255	208.9	146.3
16	13.1	09.2	76	62.3	43.6	136	111.4	78.0	196	160.6	112.4	256	209.7	146.8
17	13.9	09.8	77	63.1	44.2	137	112.2	78.6	197	161.4	113.0	257	210.5	147.4
18	14.7	10.3	78	63.9	44.7	138	113.0	79.2	198	162.2	113.6	258	211.3	148.0
19	15.6	10.9	79	64.7	45.3	139	113.9	79.7	199	163.0	114.1	259	212.2	148.6
20	16.4	11.5	80	65.5	45.9	140	114.7	80.3	200	163.8	114.7	260	213.0	149.1
21	17.2	12.0	81	66.3	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	142	116.3	81.4	202	165.5	115.9	262	214.6	150.3
23	18.8	13.2	83	68.0	47.5	143	117.1	82.0	203	166.3	116.4	263	215.4	150.9
24	19.7	13.8	84	68.9	48.1	144	118.0	82.6	204	167.1	117.0	264	216.3	151.4
25	20.5	14.3	85	69.6	48.6	145	118.8	83.2	205	167.9	117.6	265	217.1	152.0
26	21.3	14.9	86	70.4	49.1	146	119.6	83.7	206	168.7	118.2	266	217.9	152.6
27	22.1	15.5	87	71.3	49.9	147	120.4	84.3	207	169.5	118.7	267	218.7	153.1
28	22.9	16.1	88	72.1	50.5	148	121.2	84.9	208	170.3	119.3	268	219.5	153.7
29	23.8	16.6	89	72.9	51.0	149	122.1	85.5	209	171.1	119.9	269	220.4	154.3
30	24.6	17.2	90	73.7	51.6	150	122.9	86.0	210	172.0	120.5	270	221.2	154.9
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	222.0	155.4
32	26.2	18.4	92	75.3	52.8	152	124.5	87.2	212	173.7	121.6	272	222.8	156.0
33	27.0	19.0	93	76.2	53.3	153	125.3	87.8	213	174.5	122.2	273	223.6	156.6
34	27.9	19.5	94	77.0	53.9	154	126.1	88.3	214	175.3	122.7	274	224.4	157.2
35	28.7	20.1	95	77.9	54.5	155	127.0	88.9	215	176.1	123.3	275	225.3	157.7
36	29.5	20.6	96	78.7	55.1	156	127.8	89.5	216	176.9	123.9	276	226.1	158.3
37	30.3	21.2	97	79.5	55.6	157	128.6	90.1	217	177.7	124.5	277	226.9	158.9
38	31.1	21.8	98	80.3	56.2	158	129.4	90.6	218	178.5	125.0	278	227.7	159.5
39	31.9	22.4	99	81.1	56.8	159	130.2	91.2	219	179.3	125.6	279	228.5	160.0
40	32.8	22.9	100	81.9	57.4	160	131.1	91.8	220	180.1	126.2	280	229.4	160.6
41	33.6	23.5	101	82.7	57.9	161	131.9	92.3	221	181.0	126.8	281	230.2	161.2
42	34.4	24.1	102	83.6	58.5	162	132.7	92.9	222	181.9	127.3	282	231.0	161.7
43	35.2	24.7	103	84.4	59.1	163	133.5	93.5	223	182.7	127.9	283	231.8	162.3
44	36.0	25.2	104	85.2	59.7	164	134.3	94.1	224	183.5	128.5	284	232.6	162.9
45	36.9	25.8	105	86.0	60.2	165	135.2	94.6	225	184.3	129.1	285	233.4	163.5
46	37.7	26.1	106	86.8	60.8	166	136.0	95.2	226	185.1	129.6	286	234.2	164.0
47	38.5	27.0	107	87.6	61.4	167	136.8	95.8	227	185.9	130.2	287	235.0	164.6
48	39.3	27.5	108	88.3	61.9	168	137.6	96.4	228	186.7	130.8	288	235.8	165.2
49	40.1	28.1	109	89.1	62.5	169	138.4	96.9	229	187.5	131.3	289	236.6	165.8
50	41.0	28.7	110	90.1	63.1	170	139.3	97.5	230	188.3	131.9	290	237.4	166.3
51	41.8	29.3	111	90.9	63.7	171	140.1	98.1	231	189.1	132.5	291	238.2	166.9
52	42.6	29.8	112	91.7	64.2	172	140.9	98.7	232	190.0	133.1	292	239.0	167.5
53	43.4	30.4	113	92.6	64.8	173	141.7	99.2	233	190.9	133.6	293	240.0	168.1
54	44.2	31.0	114	93.4	65.4	174	142.5	99.8	234	191.7	134.2	294	240.8	168.6
55	45.1	31.5	115	94.2	66.0	175	143.4	100.4	235	192.5	134.8	295	241.6	169.2
56	45.9	32.1	116	95.0	66.5	176	144.2	100.9	236	193.3	135.4	296	242.4	169.8
57	46.7	32.7	117	95.8	67.1	177	145.0	101.5	237	194.1	135.9	297	243.2	170.4
58	47.5	33.3	118	96.7	67.7	178	145.8	102.1	238	195.0	136.5	298	244.0	170.9
59	48.3	33.8	119	97.5	68.3	179	146.6	102.7	239	195.8	137.1	299	244.8	171.5
60	49.1	34.4	120	98.3	68.8	180	147.4	103.2	240	196.6	137.7	300	245.6	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 35 Degrees.]

TABLE II.

Difference of Latitude and Departure for 36 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 8	00 6	61	49 4	36 9	121	97 9	71 1	181	146 4	106 4	241	196 0	141 7
2	01 6	01 2	62	50 2	36 4	22	98 7	71 7	82	147 2	107 0	42	195 8	142 2
3	02 4	01 8	63	51 0	37 0	23	99 5	72 3	83	148 1	107 6	43	196 6	142 8
4	03 2	02 4	64	51 8	37 6	24	100 3	72 9	84	148 9	108 2	44	197 4	143 4
5	04 0	02 9	65	52 6	38 2	25	101 1	73 5	85	149 7	108 7	45	198 2	144 0
6	04 9	03 5	66	53 4	38 8	26	101 9	74 1	86	150 5	109 3	46	199 0	144 6
7	05 7	04 1	67	54 2	39 4	27	102 7	74 6	87	151 3	109 8	47	199 8	145 2
8	05 5	04 7	68	55 0	40 0	28	103 6	75 2	88	152 1	110 5	48	200 6	145 8
9	07 3	05 3	69	55 8	40 6	29	104 4	75 8	89	152 9	111 1	49	201 4	146 4
10	08 1	05 9	70	56 6	41 1	30	105 2	76 4	90	153 7	111 7	50	202 2	146 9
11	08 9	06 5	71	57 4	41 7	31	106 0	77 0	91	154 5	112 3	51	203 1	147 5
12	09 7	07 1	72	58 2	42 3	32	106 8	77 6	92	155 3	112 9	52	203 9	148 1
13	10 5	07 6	73	59 1	42 9	33	107 6	78 2	93	156 1	113 4	53	204 7	148 7
14	11 3	08 2	74	59 9	43 5	34	108 4	78 8	94	156 9	114 0	54	205 5	149 3
15	12 1	08 8	75	60 7	44 1	35	109 2	79 4	95	157 7	114 6	55	206 3	149 9
16	12 9	09 4	76	61 5	44 7	36	110 0	79 9	96	158 5	115 2	56	207 1	150 5
17	13 8	10 0	77	62 3	45 3	37	110 8	80 5	97	159 3	115 8	57	207 9	151 1
18	14 6	10 6	78	63 1	45 8	38	111 6	81 1	98	160 2	116 4	58	208 7	151 6
19	15 4	11 2	79	63 9	46 4	39	112 4	81 7	99	161 0	117 0	59	209 5	152 2
20	16 2	11 8	80	64 7	47 0	40	113 2	82 3	200	161 8	117 6	60	210 3	152 8
21	17 0	12 4	81	65 5	47 6	41	114 1	82 9	201	162 6	118 1	61	211 1	153 4
22	17 8	12 9	82	66 3	48 2	42	114 9	83 5	02	163 4	118 7	62	212 0	154 0
23	18 6	13 5	83	67 1	48 8	43	115 7	84 1	03	164 2	119 3	63	212 8	154 6
24	19 4	14 1	84	68 0	49 4	44	116 5	84 6	04	165 0	119 9	64	213 6	155 2
25	20 2	14 7	85	68 8	50 0	45	117 3	85 2	05	165 8	120 5	65	214 4	155 8
26	21 0	15 3	86	69 6	50 5	46	118 1	85 8	06	166 7	121 1	66	215 2	156 4
27	21 8	15 9	87	70 4	51 1	47	118 9	86 4	07	167 5	121 7	67	216 0	156 9
28	22 7	16 5	88	71 2	51 7	48	119 7	87 0	08	168 3	122 3	68	216 8	157 5
29	23 5	17 0	89	72 0	52 3	49	120 5	87 6	09	169 1	122 8	69	217 6	158 1
30	24 3	17 6	90	72 8	52 9	50	121 4	88 2	10	169 9	123 4	70	218 4	158 7
31	25 1	18 2	91	73 6	53 5	51	122 2	88 8	211	170 7	124 0	71	219 2	159 3
32	25 9	18 8	92	74 4	54 1	52	123 0	89 3	12	171 5	124 6	72	220 1	159 9
33	26 7	19 4	93	75 2	54 7	53	123 8	89 9	13	172 3	125 2	73	220 9	160 5
34	27 5	20 0	94	76 0	55 3	54	124 6	90 5	14	173 1	125 8	74	221 7	161 1
35	28 3	20 6	95	76 9	55 8	55	125 4	91 1	15	173 9	126 4	75	222 5	161 6
36	29 1	21 2	96	77 7	56 4	56	126 2	91 7	16	174 7	127 0	76	223 3	162 2
37	29 9	21 7	97	78 5	57 0	57	127 0	92 3	17	175 5	127 5	77	224 1	162 8
38	30 7	22 3	98	79 3	57 6	58	127 8	92 9	18	176 3	128 1	78	224 9	163 4
39	31 5	22 9	99	80 1	58 2	59	128 6	93 5	19	177 1	128 7	79	225 7	164 0
40	32 3	23 5	100	80 9	58 8	60	129 4	94 0	20	178 0	129 3	80	226 5	164 6
41	33 1	24 1	101	81 7	59 4	61	130 2	94 6	21	178 8	129 9	81	227 3	165 2
42	34 0	24 7	02	82 5	60 0	62	131 1	95 2	22	179 6	130 5	82	228 1	165 8
43	34 8	25 3	03	83 3	60 5	63	131 9	95 8	23	180 4	131 1	83	229 0	166 4
44	35 6	25 9	04	84 1	61 1	64	132 7	96 4	24	181 2	131 7	84	229 8	166 9
45	36 4	26 5	05	84 9	61 7	65	133 5	97 0	25	182 0	132 3	85	230 6	167 5
46	37 2	27 0	06	85 8	62 3	66	134 3	97 6	26	182 8	132 8	86	231 4	168 1
47	38 0	27 6	07	86 6	62 9	67	135 1	98 2	27	183 6	133 4	87	232 2	168 7
48	38 8	28 2	08	87 4	63 5	68	135 9	98 7	28	184 4	134 0	88	233 0	169 3
49	39 6	28 8	09	88 2	64 1	69	136 7	99 3	29	185 2	134 6	89	233 8	169 9
50	40 4	29 4	10	89 0	64 7	70	137 5	99 9	30	186 1	135 2	90	234 6	170 5
51	41 2	30 0	11	89 8	65 3	71	138 3	100 5	231	186 9	135 8	291	235 4	171 1
52	42 1	30 6	12	90 6	65 8	72	139 2	101 1	32	187 7	136 4	92	236 2	171 6
53	42 9	31 2	13	91 4	66 4	73	140 0	101 7	33	188 5	137 0	93	237 0	172 2
54	43 7	31 7	14	92 2	67 0	74	140 8	102 3	34	189 3	137 5	94	237 8	172 8
55	44 5	32 3	15	93 0	67 6	75	141 6	102 9	35	190 1	138 1	95	238 6	173 4
56	45 3	32 9	16	93 8	68 2	76	142 4	103 5	36	190 9	138 7	96	239 4	174 0
57	46 1	33 5	17	94 7	68 8	77	143 2	104 1	37	191 7	139 3	97	240 2	174 6
58	46 9	34 1	18	95 5	69 4	78	144 0	104 6	38	192 5	139 9	98	241 0	175 2
59	47 7	34 7	19	96 3	69 9	79	144 8	105 2	39	193 3	140 5	99	241 8	175 7
60	48 5	35 3	20	97 1	70 5	80	145 6	105 8	40	194 1	141 1	300	242 6	176 3

[For 54 Degrees.]

TABLE II.

53

Difference of Latitude and Departure for 37 Degrees.

Lat	Dep	Dist	Lat	Dep	Dist	Lat	Dep	Dist	Lat	Dep	Dist	Lat	Dep
00 6	61	36 7	121	96 6	72 8	181	134 6	108 9	241	192 5	145 0		
01 2	62	49 5	37 3	22	97 4	73 4	82	145 4	109 5	42	193 3	146 6	
01 8	63	50 3	37 9	23	98 2	74 0	83	146 2	110 1	43	194 1	146 2	
02 4	64	51 1	38 5	24	99 0	74 6	84	147 0	110 7	44	194 9	146 8	
03 0	65	51 9	39 1	25	99 8	75 2	85	147 7	111 3	45	195 7	147 4	
03 6	66	52 7	39 7	26	100 6	75 8	86	148 5	111 9	46	196 5	148 0	
04 2	67	53 5	40 3	27	101 4	76 4	87	149 3	112 5	47	197 3	148 6	
04 8	68	54 3	40 9	28	102 2	77 0	88	150 1	113 1	48	198 1	149 3	
05 4	69	55 1	41 5	29	103 0	77 6	89	150 9	113 7	49	198 9	149 9	
06 0	70	55 9	42 1	30	103 8	78 2	90	151 7	114 3	50	199 7	150 5	
06 6	71	56 7	42 7	131	104 6	78 8	191	152 5	114 9	251	200 5	151 1	
07 2	72	57 5	43 3	32	105 4	79 4	92	153 3	115 5	52	201 3	151 7	
07 8	73	58 3	43 9	33	106 2	80 0	93	154 1	116 2	53	202 1	152 3	
08 4	74	59 1	44 5	34	107 0	80 6	94	154 9	116 8	54	202 9	152 9	
09 0	75	59 9	45 1	35	107 8	81 2	95	155 7	117 4	55	203 7	153 5	
09 6	76	60 7	45 7	36	108 6	81 8	96	156 5	118 0	56	204 5	154 1	
10 2	77	61 5	46 3	37	109 4	82 4	97	157 3	118 6	57	205 3	154 7	
10 8	78	62 3	46 9	38	110 2	83 0	98	158 1	119 2	58	206 1	155 3	
11 4	79	63 1	47 5	39	111 0	83 6	99	158 9	119 8	59	206 9	155 9	
12 0	80	63 9	48 1	40	111 8	84 2	200	159 7	120 4	60	207 7	156 5	
12 6	81	64 7	48 7	141	112 6	84 8	201	160 5	121 0	261	208 5	157 1	
13 2	82	65 5	49 3	42	113 4	85 4	02	161 3	121 6	62	209 3	157 7	
13 8	83	66 3	50 0	43	114 2	86 0	03	162 1	122 2	63	210 1	158 3	
14 4	84	67 1	50 6	44	115 0	86 6	04	162 9	122 8	64	210 9	158 9	
15 0	85	67 9	51 2	45	115 8	87 2	05	163 7	123 4	65	211 7	159 5	
15 6	86	68 7	51 8	46	116 6	87 8	06	164 5	124 0	66	212 5	160 1	
16 2	87	69 5	52 4	47	117 4	88 4	07	165 3	124 6	67	213 3	160 7	
16 8	88	70 3	53 0	48	118 2	89 0	08	166 1	125 2	68	214 1	161 3	
17 4	89	71 1	53 6	49	119 0	89 6	09	166 9	125 8	69	214 9	161 9	
18 0	90	71 9	54 2	50	119 8	90 2	10	167 7	126 4	70	215 7	162 5	
18 6	91	72 7	54 8	151	120 6	90 8	211	168 5	127 0	271	216 5	163 1	
19 2	92	73 5	55 4	52	121 4	91 4	12	169 3	127 6	72	217 3	163 7	
19 8	93	74 3	56 0	53	122 2	92 0	13	170 1	128 2	73	218 1	164 3	
20 4	94	75 1	56 6	54	123 0	92 6	14	170 9	128 8	74	218 9	164 9	
21 0	95	75 9	57 2	55	123 8	93 2	15	171 7	129 4	75	219 7	165 5	
21 6	96	76 7	57 8	56	124 6	93 8	16	172 5	130 0	76	220 5	166 1	
22 2	97	77 5	58 4	57	125 4	94 4	17	173 3	130 6	77	221 3	166 7	
22 8	98	78 3	59 0	58	126 2	95 0	18	174 1	131 2	78	222 1	167 3	
23 4	99	79 1	59 6	59	127 0	95 6	19	174 9	131 8	79	222 9	167 9	
24 0	100	79 9	60 2	60	127 8	96 2	20	175 7	132 4	80	223 7	168 5	
24 6	101	80 7	60 8	161	128 6	96 8	221	176 5	133 0	281	224 5	169 1	
25 2	02	81 5	61 4	62	129 4	97 4	22	177 3	133 6	82	225 3	169 7	
25 8	03	82 3	62 0	63	130 2	98 0	23	178 1	134 2	83	226 1	170 3	
26 4	04	83 1	62 6	64	131 0	98 6	24	178 9	134 8	84	226 9	170 9	
27 0	05	83 9	63 2	65	131 8	99 2	25	179 7	135 4	85	227 7	171 5	
27 6	06	84 7	63 8	66	132 6	99 8	26	180 5	136 0	86	228 5	172 1	
28 2	07	85 5	64 4	67	133 4	100 4	27	181 3	136 6	87	229 3	172 7	
28 8	08	86 3	65 0	68	134 2	101 0	28	182 1	137 2	88	230 1	173 3	
29 4	09	87 1	65 6	69	135 0	101 6	29	182 9	137 8	89	230 9	173 9	
30 0	10	87 9	66 2	70	135 8	102 2	30	183 7	138 4	90	231 7	174 5	
30 6	111	88 7	66 8	171	136 6	102 8	231	184 5	139 0	291	232 5	175 1	
31 2	12	89 5	67 4	72	137 4	103 4	32	185 3	139 6	92	233 3	175 7	
31 8	13	90 3	68 0	73	138 2	104 0	33	186 1	140 2	93	234 1	176 3	
32 4	14	91 1	68 6	74	139 0	104 6	34	186 9	140 8	94	234 9	176 9	
33 0	15	91 9	69 2	75	139 8	105 2	35	187 7	141 4	95	235 7	177 5	
33 6	16	92 7	69 8	76	140 6	105 8	36	188 5	142 0	96	236 5	178 1	
34 2	17	93 5	70 4	77	141 4	106 4	37	189 3	142 6	97	237 3	178 7	
34 8	18	94 3	71 0	78	142 2	107 0	38	190 1	143 2	98	238 1	179 3	
35 4	19	95 1	71 6	79	143 0	107 6	39	190 9	143 8	99	238 9	179 9	
36 0	20	95 9	72 2	80	143 8	108 2	40	191 7	144 4	300	239 7	180 5	
Lat	Dist	Dep.	Lat	Dist	Dep.	Lat	Dist	Dep.	Lat	Dist	Dep.	Lat	Dist

{For 53 Degrees.

TABLE II.

Difference of Latitude and Departure for 38 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 8	00.6	61	48 1	37.6	121	95.3	74.5	181	142 6	111.4	241	189 9	148.4
2	01 6	01.2	62	48 9	38.2	22	96.1	75.1	82	143.4	112.1	42	190 7	149.0
3	02 4	01.8	63	49 6	38.8	23	96 9	75.7	83	144.2	112.7	43	191.5	149.6
4	03 2	02.5	64	50 4	39.4	24	97 7	76.3	84	145.0	113.3	44	192 3	150.2
5	03 9	03.1	65	51 2	40.0	25	98 5	77.0	85	145.8	113.9	45	193.1	150.8
6	04 7	03.7	66	52 0	40.6	26	99 3	77.6	86	146 6	114.5	46	193.9	151.5
7	05 5	04.3	67	52 8	41.2	27	100 1	78.2	87	147.4	115.1	47	194.6	152.1
8	06 3	04.9	68	53 6	41.9	28	100 9	78.8	88	148.1	115.7	48	195.4	152.7
9	07 1	05.5	69	54.4	42.5	29	101.7	79.4	89	148.9	116.4	49	196 2	153.3
10	07 9	06.2	70	55 2	43.1	30	102 4	80.0	90	149 7	117.0	50	197.0	153.9
11	08 7	06.8	71	55 9	43.7	131	103 2	80.7	191	150 5	117.6	251	197.8	154.5
12	09 5	07.4	72	56 7	44.3	32	104 0	81.3	92	151 3	118.2	52	198 6	155.1
13	10 2	08.0	73	57 5	44.9	33	104 8	81.9	93	152.1	118.8	53	199 4	155.8
14	11 0	08.6	74	58 3	45.6	34	105 6	82.5	94	152.9	119.4	54	200.2	156.4
15	11 8	09.2	75	59.1	46.2	35	106 4	83.1	95	153.7	120.1	55	200.9	157.0
16	12 6	09.9	76	59 9	46.8	36	107.2	83.7	96	154 5	120.7	56	201 7	157.6
17	13.4	10.5	77	60 7	47.4	37	108 0	84.3	97	155 2	121.3	57	202.5	158.2
18	14 2	11.1	78	61 5	48.0	38	108.7	85.0	98	156.0	121.9	58	203.3	158.8
19	15 0	11.7	79	62 3	48.6	39	109 5	85.6	99	156 8	122.5	59	204 1	159.5
20	15 8	12.3	80	63.0	49.3	40	110.3	86.2	200	157 6	123.1	60	204 9	160.1
21	16.5	12.9	81	63 8	49.9	141	111.1	86.8	201	158 4	123.7	261	205 7	160.7
22	17 3	13.5	82	64 6	50.5	42	111 9	87.4	02	159 2	124.4	62	206 5	161.3
23	18 1	14.2	83	65 4	51.1	43	112.7	88.0	03	160.0	125.0	63	207 2	161.9
24	18 9	14.8	84	66 2	51.7	44	113.5	88.7	04	160.8	125.6	64	208.0	162.5
25	19 7	15.4	85	67 0	52.3	45	114 3	89.3	05	161.5	126.2	65	208 8	163.2
26	20 5	16.0	86	67 8	52.9	46	115 0	89.9	06	162.3	126.8	66	209.6	163.8
27	21 3	16.6	87	68 6	53.6	47	115 8	90.5	07	163.1	127.4	67	210.4	164.4
28	22 1	17.2	88	69 3	54.2	48	116 6	91.1	08	163 9	128.1	68	211.2	165.0
29	22 9	17.9	89	70.1	54.8	49	117 4	91.7	09	164 7	128.7	69	212 0	165.6
30	23 6	18.5	90	70 9	55.4	50	118.2	92.3	10	165.5	129.3	70	212 8	166.2
31	24 4	19.1	91	71.7	56.0	151	119.0	93.0	211	166.3	129.9	271	213 6	166.8
32	25 2	19.7	92	72 5	56.6	52	119 8	93.6	12	167 1	130.5	72	214 3	167.5
33	26 0	20.3	93	73 3	57.3	53	120 6	94.2	13	167.8	131.1	73	215.1	168.1
34	26 8	20.9	94	74 1	57.9	54	121 4	94.8	14	168 6	131.8	74	215.9	168.7
35	27 6	21.5	95	74 9	58.5	55	122 1	95.4	15	169.4	132.4	75	216 7	169.3
36	28 4	22.2	96	75 6	59.1	56	122 9	96.0	16	170.2	133.0	76	217.5	169.9
37	29 2	22.8	97	76 4	59.7	57	123.7	96.7	17	171 0	133.6	77	218 3	170.5
38	29 9	23.4	98	77 2	60.3	58	124 5	97.3	18	171.8	134.2	78	219 1	171.2
39	30 7	24.0	99	78 0	61.0	59	125 3	97.9	19	172 6	134.8	79	219 9	171.8
40	31 5	24.6	100	78 8	61.6	60	126 1	98.5	20	173 4	135.4	80	220 6	172.4
41	32 3	25.2	101	79 6	62.2	161	126.9	99.1	221	174 2	136.1	281	221 4	173.0
42	33.1	25.9	02	80 4	62.8	62	127 7	99.7	22	174 9	136.7	82	222 2	173.6
43	33 9	26.5	03	81 2	63.4	63	128 4	100.4	23	175.7	137.3	83	223 0	174.2
44	34.7	27.1	04	82 0	64.0	64	129.2	101.0	24	176.5	137.9	84	223.8	174.8
45	35 5	27.7	05	82 7	64.6	65	130.0	101.6	25	177 3	138.5	85	224 6	175.5
46	36.2	28.3	06	83.5	65.3	66	130 8	102.2	26	178.1	139.1	86	225 4	176.1
47	37 0	28.9	07	84.3	65.9	67	131 5	102.8	27	178.9	139.8	87	226 2	176.7
48	37 8	29.6	08	85 1	66.5	68	132 4	103.4	28	179.7	140.4	88	227 0	177.3
49	38 6	30.2	09	85 9	67.1	69	133 2	104.0	29	180 5	141.0	89	227 7	177.9
50	39 4	30.8	10	86.7	67.7	70	134 0	104.7	30	181.2	141.6	90	228 5	178.5
51	40 2	31.4	111	87 5	68.3	171	134.7	105.3	231	182 0	142.2	291	229 3	179.1
52	41 0	32.0	12	88 3	69.0	72	135 5	105.9	32	182.8	142.8	92	230.1	179.8
53	41 8	32.6	13	89 0	69.6	73	136 3	106.5	33	183 6	143.4	93	230 9	180.4
54	42 6	33.2	14	89 8	70.2	74	137 1	107.1	34	184 4	144.1	94	231 7	181.0
55	43 3	33.9	15	90 6	70.8	75	137 9	107.7	35	185 2	144.7	95	232 5	181.6
56	44.1	34.5	16	91 4	71.4	76	138.7	108.4	36	186 0	145.3	96	233 3	182.2
57	44.9	35.1	17	92 2	72.0	77	139.5	109.0	37	186.8	145.9	97	234 1	182.9
58	45 7	35.7	18	93.0	72.6	78	140 3	109.6	38	187 5	146.5	98	234.8	183.5
59	46 5	36.3	19	93.8	73.3	79	141.1	110.2	39	188 3	147.1	99	235 6	184.1
60	47.3	36.9	20	94 6	73.9	80	141.8	110.8	40	189 1	147.8	300	236 4	184.7
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.

[For 38 Degrees.]

TABLE II.

Difference of Latitude and Departure for 39 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	22	94.8	76.8	82	141.4	114.5	42	188.1	152.3
3	02.3	01.9	63	49.0	39.6	23	95.6	77.4	83	142.2	115.2	43	188.8	152.9
4	03.1	02.5	64	49.7	40.3	24	96.4	78.0	84	143.0	115.8	44	189.6	153.6
5	03.9	03.1	65	50.5	40.9	25	97.1	78.7	85	143.8	116.4	45	190.4	154.2
6	04.7	03.8	66	51.3	41.5	26	97.9	79.3	86	144.5	117.1	46	191.2	154.8
7	05.4	04.4	67	52.1	42.2	27	98.7	79.9	87	145.3	117.7	47	192.0	155.4
8	06.2	05.0	68	52.8	42.8	28	99.5	80.6	88	146.1	118.3	48	192.7	156.1
9	07.0	05.7	69	53.6	43.4	29	100.3	81.2	89	146.9	118.9	49	193.5	156.7
10	07.8	06.3	70	54.4	44.1	30	101.0	81.8	90	147.7	119.6	50	194.3	157.3
11	08.5	06.9	71	55.2	44.7	31	101.8	82.4	91	148.4	120.2	51	195.1	158.0
12	09.3	07.6	72	56.0	45.3	32	102.6	83.1	92	149.2	120.8	52	195.8	158.6
13	10.1	08.2	73	56.7	45.9	33	103.4	83.7	93	150.0	121.5	53	196.6	159.2
14	10.9	08.8	74	57.5	46.6	34	104.1	84.3	94	150.8	122.1	54	197.4	159.8
15	11.7	09.4	75	58.3	47.2	35	104.9	85.0	95	151.5	122.7	55	198.2	160.5
16	12.4	10.1	76	59.1	47.8	36	105.7	85.6	96	152.3	123.3	56	198.9	161.1
17	13.2	10.7	77	59.8	48.5	37	106.5	86.2	97	153.1	124.0	57	199.7	161.7
18	14.0	11.3	78	60.6	49.1	38	107.2	86.8	98	153.9	124.6	58	200.5	162.4
19	14.8	12.0	79	61.4	49.7	39	108.0	87.5	99	154.7	125.2	59	201.3	163.0
20	15.5	12.6	80	62.2	50.3	40	108.8	88.1	200	155.4	125.9	60	202.1	163.6
21	16.3	13.2	81	62.9	51.0	41	109.6	88.7	201	156.2	126.5	61	202.8	164.3
22	17.1	13.8	82	63.7	51.6	42	110.4	89.4	02	157.0	127.1	62	203.6	164.9
23	17.9	14.5	83	64.5	52.2	43	111.1	90.0	03	157.8	127.8	63	204.4	165.5
24	18.7	15.1	84	65.3	52.9	44	111.9	90.6	04	158.5	128.4	64	205.2	166.1
25	19.4	15.7	85	66.1	53.5	45	112.7	91.3	05	159.3	129.0	65	205.9	166.8
26	20.2	16.4	86	66.8	54.1	46	113.5	91.9	06	160.1	129.6	66	206.7	167.4
27	21.0	17.0	87	67.6	54.8	47	114.2	92.5	07	160.9	130.3	67	207.5	168.0
28	21.8	17.6	88	68.4	55.4	48	115.0	93.1	08	161.6	130.9	68	208.3	168.7
29	22.5	18.3	89	69.2	56.0	49	115.8	93.8	09	162.4	131.5	69	209.1	169.3
30	23.3	18.9	90	69.9	56.6	50	116.6	94.4	10	163.2	132.2	70	209.8	169.9
31	24.1	19.5	91	70.7	57.3	51	117.3	95.0	11	164.0	132.8	71	210.6	170.5
32	24.9	20.1	92	71.5	57.9	52	118.1	95.7	12	164.8	133.4	72	211.4	171.2
33	25.6	20.8	93	72.3	58.5	53	118.9	96.3	13	165.5	134.0	73	212.2	171.8
34	26.4	21.4	94	73.1	59.2	54	119.7	96.9	14	166.3	134.7	74	212.9	172.4
35	27.2	22.0	95	73.8	59.8	55	120.5	97.5	15	167.1	135.3	75	213.7	173.1
36	28.0	22.7	96	74.6	60.4	56	121.2	98.2	16	167.9	135.9	76	214.5	173.7
37	28.8	23.3	97	75.4	61.0	57	122.0	98.8	17	168.6	136.6	77	215.3	174.3
38	29.5	23.9	98	76.2	61.7	58	122.8	99.4	18	169.4	137.2	78	216.0	175.0
39	30.3	24.5	99	76.9	62.3	59	123.6	100.1	19	170.2	137.8	79	216.8	175.6
40	31.1	25.2	100	77.7	62.9	60	124.3	100.7	20	171.0	138.5	80	217.6	176.2
41	31.9	25.8	101	78.5	63.6	61	125.1	101.3	21	171.7	139.1	81	218.4	176.8
42	32.6	26.4	02	79.3	64.2	62	125.9	101.9	22	172.5	139.7	82	219.2	177.5
43	33.4	27.1	03	80.0	64.8	63	126.7	102.6	23	173.3	140.3	83	219.9	178.1
44	34.2	27.7	04	80.8	65.4	64	127.5	103.2	24	174.1	141.0	84	220.7	178.7
45	35.0	28.3	05	81.6	66.1	65	128.2	103.8	25	174.9	141.6	85	221.5	179.4
46	35.7	28.9	06	82.4	66.7	66	129.0	104.5	26	175.6	142.2	86	222.3	180.0
47	36.5	29.6	07	83.2	67.3	67	129.8	105.1	27	176.4	142.9	87	223.0	180.6
48	37.3	30.2	08	83.9	68.0	68	130.6	105.7	28	177.2	143.5	88	223.8	181.2
49	38.1	30.8	09	84.7	68.6	69	131.3	106.4	29	178.0	144.1	89	224.6	181.9
50	38.9	31.5	10	85.5	69.2	70	132.1	107.0	30	178.7	144.7	90	225.4	182.5
51	39.6	32.1	11	86.3	69.9	71	132.9	107.6	31	179.5	145.4	91	226.1	183.1
52	40.4	32.7	12	87.0	70.5	72	133.7	108.2	32	180.3	146.0	92	226.9	183.8
53	41.2	33.4	13	87.8	71.1	73	134.4	108.9	33	181.1	146.6	93	227.7	184.4
54	42.0	34.0	14	88.6	71.7	74	135.2	109.5	34	181.9	147.3	94	228.5	185.0
55	42.7	34.6	15	89.4	72.4	75	136.0	110.1	35	182.6	147.9	95	229.3	185.6
56	43.5	35.2	16	90.1	73.0	76	136.8	110.8	36	183.4	148.5	96	230.0	186.3
57	44.3	35.9	17	90.9	73.6	77	137.6	111.4	37	184.2	149.1	97	230.8	186.9
58	45.1	36.5	18	91.7	74.3	78	138.3	112.0	38	185.0	149.7	98	231.6	187.5
59	45.9	37.1	19	92.5	74.9	79	139.1	112.6	39	185.7	150.4	99	232.4	188.2
60	46.6	37.8	20	93.3	75.5	80	139.9	113.2	40	186.5	151.0	300	233.1	188.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 51 Degrees.]

TABLE II.

Difference of Latitude and Departure for 40 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	241	184.6	154.9
2	01.5	01.3	62	47.5	39.9	122	93.5	78.4	182	139.4	117.0	242	185.6	155.6
3	02.3	01.9	63	48.3	40.5	123	94.2	79.1	183	140.2	117.6	243	186.1	156.2
4	03.1	02.6	64	49.0	41.1	124	95.0	79.7	184	141.0	118.3	244	187.1	156.8
5	03.8	03.2	65	49.8	41.8	125	95.8	80.3	185	141.7	118.9	245	187.7	157.5
6	04.6	03.9	66	50.6	42.4	126	96.5	81.0	186	142.5	119.6	246	188.4	158.1
7	05.4	04.5	67	51.3	43.1	127	97.3	81.6	187	143.3	120.2	247	189.2	158.8
8	06.1	05.1	68	52.1	43.7	128	98.1	82.3	188	144.0	120.9	248	190.0	159.4
9	06.9	05.8	69	52.9	44.4	129	98.8	82.9	189	144.8	121.5	249	190.7	160.1
10	07.7	06.4	70	53.6	45.0	130	99.6	83.6	190	145.5	122.1	250	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	09.2	07.7	72	55.2	46.3	132	101.1	84.8	192	147.1	123.4	252	193.0	162.0
13	10.0	08.4	73	55.9	46.9	133	101.9	85.5	193	147.8	124.1	253	193.7	162.6
14	10.7	09.0	74	56.7	47.6	134	102.6	86.1	194	148.6	124.7	254	194.4	163.3
15	11.5	09.6	75	57.5	48.2	135	103.4	86.8	195	149.4	125.3	255	195.1	163.9
16	12.3	10.3	76	58.2	48.9	136	104.2	87.4	196	150.1	126.0	256	195.8	164.6
17	13.0	10.9	77	59.0	49.5	137	104.9	88.1	197	150.9	126.6	257	196.5	165.2
18	13.8	11.6	78	59.8	50.1	138	105.7	88.7	198	151.7	127.3	258	197.2	165.8
19	14.6	12.2	79	60.6	50.8	139	106.5	89.3	199	152.4	127.9	259	198.0	166.5
20	15.3	12.9	80	61.3	51.4	140	107.2	90.0	200	153.2	128.5	260	198.7	167.1
21	16.1	13.6	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.4	167.8
22	16.9	14.1	82	62.8	52.7	142	108.8	91.3	202	154.7	129.8	262	200.1	168.4
23	17.6	14.8	83	63.6	53.4	143	109.5	91.9	203	155.5	130.5	263	200.8	169.1
24	18.4	15.4	84	64.3	54.0	144	110.3	92.6	204	156.3	131.1	264	201.5	169.7
25	19.2	16.1	85	65.1	54.6	145	111.1	93.2	205	157.1	131.8	265	202.2	170.3
26	19.9	16.7	86	65.9	55.3	146	111.8	93.8	206	157.8	132.4	266	202.9	171.0
27	20.7	17.4	87	66.6	55.9	147	112.6	94.5	207	158.6	133.1	267	203.6	171.6
28	21.4	18.0	88	67.4	56.6	148	113.4	95.1	208	159.4	133.7	268	204.3	172.3
29	22.2	18.6	89	68.2	57.2	149	114.1	95.8	209	160.1	134.3	269	205.0	172.9
30	23.0	19.3	90	68.9	57.9	150	114.9	96.4	210	160.9	135.0	270	205.7	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	206.4	174.2
32	24.5	20.6	92	70.5	59.1	152	116.4	97.7	212	162.4	136.3	272	207.1	174.8
33	25.3	21.2	93	71.2	59.8	153	117.2	98.3	213	163.2	136.9	273	207.8	175.5
34	26.0	21.9	94	72.0	60.4	154	118.0	99.0	214	163.9	137.6	274	208.5	176.1
35	26.8	22.5	95	72.8	61.1	155	118.7	99.6	215	164.7	138.2	275	209.2	176.8
36	27.6	23.1	96	73.5	61.7	156	119.5	100.3	216	165.5	138.9	276	209.9	177.4
37	28.3	23.8	97	74.3	62.4	157	120.3	100.9	217	166.3	139.5	277	210.6	178.1
38	29.1	24.4	98	75.1	63.0	158	121.0	101.6	218	167.1	140.1	278	211.3	178.7
39	29.9	25.1	99	75.8	63.6	159	121.8	102.2	219	167.8	140.8	279	212.0	179.3
40	30.6	25.7	100	76.6	64.3	160	122.6	102.8	220	168.6	141.4	280	212.7	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.4	142.1	281	213.4	180.6
42	32.2	27.0	102	78.1	65.6	162	124.1	104.1	222	170.2	142.7	282	214.1	181.3
43	32.9	27.6	103	78.9	66.2	163	124.9	104.8	223	171.0	143.3	283	214.8	181.9
44	33.7	28.3	104	79.7	66.8	164	125.6	105.4	224	171.8	144.0	284	215.5	182.6
45	34.5	28.9	105	80.4	67.5	165	126.4	106.1	225	172.6	144.6	285	216.2	183.2
46	35.2	29.6	106	81.2	68.1	166	127.2	106.7	226	173.4	145.3	286	216.9	183.8
47	36.0	30.2	107	82.0	68.8	167	127.9	107.3	227	174.2	145.9	287	217.6	184.5
48	36.8	30.9	108	82.7	69.4	168	128.7	108.0	228	175.0	146.6	288	218.3	185.1
49	37.5	31.5	109	83.5	70.1	169	129.5	108.6	229	175.8	147.2	289	219.0	185.8
50	38.3	32.1	110	84.3	70.7	170	130.3	109.3	230	176.6	147.8	290	219.7	186.4
51	39.1	32.8	111	85.0	71.3	171	131.1	109.9	231	177.4	148.5	291	220.4	187.1
52	39.8	33.4	112	85.8	72.0	172	131.8	110.6	232	178.2	149.1	292	221.1	187.7
53	40.6	34.1	113	86.6	72.6	173	132.6	111.2	233	179.0	149.8	293	221.8	188.3
54	41.4	34.7	114	87.3	73.3	174	133.4	111.8	234	179.8	150.4	294	222.5	189.0
55	42.1	35.4	115	88.1	73.9	175	134.1	112.5	235	180.6	151.1	295	223.2	189.6
56	42.9	36.0	116	88.9	74.6	176	134.9	113.1	236	181.4	151.7	296	223.9	190.3
57	43.7	36.6	117	89.7	75.2	177	135.6	113.8	237	182.2	152.3	297	224.6	190.9
58	44.4	37.3	118	90.4	75.8	178	136.4	114.4	238	183.0	153.0	298	225.3	191.6
59	45.2	37.9	119	91.2	76.5	179	137.2	115.1	239	183.8	153.6	299	226.0	192.2
60	46.0	38.6	120	91.9	77.1	180	137.9	115.7	240	184.6	154.3	300	226.7	192.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 40 Degrees.]

TABLE II.

57

Difference of Latitude and Departure for 41 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.6	01.3	62	46.8	40.7	22	92.1	80.0	82	137.4	119.4	42	182.6	158.8
3	02.3	02.0	63	47.5	41.3	23	92.8	80.7	83	138.1	120.1	43	183.4	159.4
4	03.0	02.6	64	48.3	42.0	24	93.6	81.4	84	138.9	120.7	44	184.1	160.1
5	03.8	03.3	65	49.1	42.6	25	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	04.5	03.9	66	49.8	43.2	26	95.1	82.7	86	140.4	122.0	46	185.7	161.4
7	05.3	04.6	67	50.6	44.0	27	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	06.0	05.2	68	51.3	44.6	28	96.6	84.0	88	141.9	123.3	48	187.2	162.7
9	06.8	05.9	69	52.1	45.3	29	97.4	84.6	89	142.6	124.0	49	187.9	163.4
10	07.5	06.6	70	52.8	45.9	30	98.1	85.3	90	143.4	124.7	50	188.7	164.0
11	08.3	07.2	71	53.6	46.6	31	98.9	85.9	91	144.1	125.3	51	189.4	164.7
12	09.1	07.9	72	54.3	47.2	32	99.6	86.6	92	144.9	126.0	52	190.2	165.3
13	09.8	08.6	73	55.1	47.9	33	100.4	87.3	93	145.7	126.6	53	190.9	166.0
14	10.6	09.2	74	55.8	48.5	34	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	11.3	09.8	75	56.6	49.2	35	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	12.1	10.5	76	57.4	49.9	36	102.6	89.2	96	147.9	128.6	56	193.2	168.0
17	12.8	11.2	77	58.1	50.5	37	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	13.6	11.8	78	58.9	51.2	38	104.1	90.5	98	149.4	129.9	58	194.7	169.3
19	14.3	12.5	79	59.6	51.8	39	104.9	91.2	99	150.2	130.6	59	195.5	169.9
20	15.1	13.1	80	60.4	52.5	40	105.7	91.8	200	150.9	131.2	60	196.2	170.6
21	15.8	13.8	81	61.1	53.1	41	106.4	92.5	201	151.7	131.9	61	197.0	171.2
22	16.6	14.4	82	61.9	53.7	42	107.2	93.2	02	152.5	132.5	62	197.7	171.9
23	17.4	15.1	83	62.6	54.5	43	107.9	93.8	03	153.2	133.2	63	198.5	172.6
24	18.1	15.7	84	63.4	55.1	44	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	18.9	16.4	85	64.2	55.8	45	109.4	95.1	05	154.7	134.5	65	200.0	173.9
26	19.6	17.1	86	64.9	56.4	46	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	20.4	17.7	87	65.7	57.1	47	110.9	96.4	07	156.2	135.8	67	201.5	175.2
28	21.1	18.4	88	66.4	57.7	48	111.7	97.1	08	157.0	136.5	68	202.3	175.8
29	21.9	19.0	89	67.2	58.4	49	112.5	97.8	09	157.7	137.1	69	203.0	176.5
30	22.6	19.7	90	67.9	59.0	50	113.2	98.4	10	158.5	137.8	70	203.8	177.1
31	23.4	20.3	91	68.7	59.7	51	114.0	99.1	21	159.2	138.4	71	204.5	177.8
32	24.2	21.0	92	69.4	60.4	52	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	24.9	21.6	93	70.2	61.0	53	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	25.7	22.3	94	70.9	61.7	54	116.2	101.0	14	161.5	140.4	74	206.8	179.8
35	26.4	22.9	95	71.7	62.3	55	117.0	101.7	15	162.3	141.1	75	207.5	180.4
36	27.1	23.6	96	72.5	63.0	56	117.7	102.3	16	163.0	141.7	76	208.3	181.1
37	27.9	24.3	97	73.2	63.6	57	118.5	103.0	17	163.8	142.4	77	209.1	181.7
38	28.7	24.9	98	74.0	64.3	58	119.2	103.7	18	164.5	143.0	78	209.8	182.4
39	29.4	25.6	99	74.7	64.9	59	120.0	104.3	19	165.3	143.7	79	210.6	183.0
40	30.2	26.2	100	75.5	65.6	60	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	31.0	26.9	101	76.2	66.3	61	121.5	105.6	21	166.8	145.0	81	212.1	184.4
42	31.7	27.6	02	77.0	66.9	62	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	32.5	28.3	03	77.7	67.6	63	123.0	106.9	23	168.3	146.3	83	213.6	185.7
44	33.2	28.9	04	78.5	68.2	64	123.8	107.6	24	169.1	147.0	84	214.3	186.3
45	34.0	29.5	05	79.2	68.9	65	124.5	108.2	25	169.8	147.6	85	215.1	187.0
46	34.7	30.2	06	80.0	69.5	66	125.3	108.9	26	170.6	148.3	86	215.8	187.6
47	35.5	30.8	07	80.8	70.2	67	126.0	109.6	27	171.3	148.9	87	216.6	188.3
48	36.2	31.5	08	81.5	70.9	68	126.8	110.2	28	172.1	149.6	88	217.4	188.9
49	37.0	32.1	09	82.3	71.5	69	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	37.7	32.8	10	83.0	72.2	70	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	38.5	33.5	11	83.8	72.8	71	129.1	112.2	31	174.3	151.5	91	219.6	190.9
52	39.2	34.1	12	84.5	73.5	72	129.8	112.8	32	175.1	152.2	92	220.4	191.6
53	40.0	34.8	13	85.3	74.1	73	130.6	113.5	33	175.8	152.9	93	221.1	192.2
54	40.8	35.4	14	86.0	74.8	74	131.3	114.2	34	176.6	153.5	94	221.9	192.9
55	41.5	36.1	15	86.8	75.4	75	132.1	114.8	35	177.4	154.2	95	222.6	193.5
56	42.3	36.7	16	87.5	76.1	76	132.8	115.5	36	178.1	154.8	96	223.4	194.2
57	43.0	37.4	17	88.3	76.8	77	133.6	116.1	37	178.9	155.5	97	224.1	194.8
58	43.8	38.1	18	89.1	77.4	78	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	44.5	38.7	19	89.8	78.1	79	135.1	117.4	39	180.4	156.8	99	225.7	196.2
60	45.3	39.4	20	90.6	78.7	80	135.9	118.1	40	181.1	157.5	300	226.4	196.8
Lat.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 49 Degrees.]

TABLE II.

Difference of Latitude and Departure for 42 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 7	00.7	61	45 3	40.8	121	89.9	81.0	181	135 5	121.1	241	179.1	161.3
2	01 5	01.3	62	46.1	41.5	122	90.7	81.6	182	136 3	121.8	242	179.8	161.9
3	02 2	02.0	63	46.8	42.2	123	91.4	82.3	183	136 0	122.5	243	180.6	162.6
4	03 0	02.7	64	47 6	42.8	124	92.1	83.0	184	136 7	123.1	244	181.3	163.3
5	03 7	03.3	65	48 3	43.5	125	92 9	83 6	185	137 5	123.8	245	182.1	163.9
6	04 5	04.0	66	49 0	44.2	126	93 6	84 3	186	138 2	124.5	246	182.8	164.6
7	05 2	04.7	67	49.8	44.8	127	94 4	85 0	187	139 0	125.1	247	183.6	165.3
8	05 9	05.4	68	50 5	45.5	128	95 1	85 6	188	139 7	125.8	248	184.3	165.9
9	06 7	06.0	69	51.3	46.2	129	95 9	86 3	189	140 5	126.5	249	185 0	166.6
10	07.4	06.7	70	52.0	46.8	130	96 6	87.0	190	141 2	127.1	250	185 8	167.3
11	08.2	07.4	71	52.8	47.5	131	97 4	87.7	191	141 9	127.8	251	186.5	168.0
12	08 9	08.0	72	53.5	48.2	132	98 1	88 3	192	142 7	128.5	252	187.3	168.6
13	09 7	08.7	73	54 2	48.8	133	98 8	89 0	193	143 4	129.1	253	188 0	169.3
14	10.4	09.4	74	55 0	49.5	134	99 6	89 7	194	144 2	129.8	254	188 8	170.0
15	11.1	10.0	75	55 7	50.2	135	100.3	90 3	195	144 9	130.5	255	189 5	170.7
16	11.9	10.7	76	56.5	50.9	136	101 1	91 0	196	145 7	131.1	256	190.2	171.3
17	12 6	11.4	77	57 2	51.5	137	101 8	91 7	197	146 4	131.8	257	191 0	172.0
18	13 4	12.0	78	58 0	52.2	138	102 6	92.3	198	147 1	132.5	258	191 7	172.6
19	14 1	12.7	79	58 7	52.9	139	103 3	93 0	199	147 9	133.2	259	192 5	173.3
20	14 9	13.4	80	59 5	53.5	140	104 0	93.7	200	148 6	133.8	260	193 2	174.0
21	15 6	14.1	81	60 2	54.2	141	104 8	94 3	201	149.4	134.5	261	194 0	174.6
22	16 3	14.7	82	60 9	54.9	142	105 5	95 0	202	150.1	135.2	262	194.7	175.3
23	17 1	15.4	83	61 7	55.5	143	106 3	95 7	203	150 9	135.8	263	195 4	176.0
24	17 8	16.1	84	62 4	56.2	144	107.0	96 4	204	151.6	136.5	264	196.2	176.7
25	18 6	16.7	85	63 2	56.9	145	107 8	97 0	205	152.3	137.2	265	196 9	177.3
26	19 3	17.4	86	63 9	57.5	146	108 5	97.7	206	153 1	137.8	266	197.7	178.0
27	20 1	18.1	87	64 7	58.2	147	109 2	98.4	207	153.8	138.5	267	198 4	178.7
28	20 8	18.7	88	65 4	58.9	148	110 0	99 0	208	154 6	139.2	268	199.2	179.3
29	21.6	19.4	89	66.1	59.5	149	110 7	99 7	209	155 3	139.8	269	199 9	180.0
30	22 3	20.1	90	66 9	60.2	150	111 5	100 4	210	156.1	140.5	270	200 6	180.7
31	23 0	20.7	91	67 6	60.9	151	112 2	101 0	211	156 8	141.2	271	201 4	181.3
32	23.8	21.4	92	68 4	61.6	152	113 0	101 7	212	157 5	141.9	272	202 1	182.0
33	24 5	22.1	93	69 1	62.2	153	113 7	102 4	213	158 3	142.5	273	202 9	182.7
34	25 3	22.8	94	69 9	62.9	154	114 4	103 0	214	159 0	143.2	274	203 6	183.3
35	26 0	23.4	95	70 6	63.6	155	115 2	103 7	215	159 8	143.9	275	204 4	184.0
36	26 8	24.1	96	71.3	64.2	156	115 9	104 4	216	160 5	144.5	276	205 1	184.7
37	27.5	24.8	97	72 1	64.9	157	116 7	105 1	217	161 3	145.2	277	205 9	185.3
38	28 2	25.4	98	72 8	65.6	158	117 4	105 7	218	162.0	145.9	278	206 6	186.0
39	29.0	26.1	99	73.6	66.2	159	118 2	106 4	219	162 7	146.5	279	207 3	186.7
40	29 7	26.8	100	74 3	66.9	160	118 9	107 1	220	163.5	147.2	280	208 1	187.4
41	30 5	27.4	101	75 1	67.6	161	119 6	107 7	221	164.2	147.9	281	208 8	188.0
42	31 2	28.1	102	75 8	68.3	162	120 4	108 4	222	165.0	148.5	282	209 6	188.7
43	32 0	28.8	103	76 5	68.9	163	121 1	109 1	223	165.7	149.2	283	210 3	189.4
44	32.7	29.4	104	77 3	69.6	164	121 9	109 7	224	166 5	149.9	284	211 1	190.0
45	33 4	30.1	105	78 0	70.3	165	122 6	110 4	225	167 2	150.6	285	211 8	190.7
46	34 2	30.8	106	78 8	70.9	166	123 4	111 1	226	168 0	151.2	286	212 5	191.4
47	34.9	31.4	107	79.5	71.6	167	124 1	111 7	227	168 7	151.9	287	213 3	192.0
48	35 7	32.1	108	80 3	72.3	168	124 8	112.4	228	169 4	152.6	288	214 0	192.7
49	36 4	32.8	109	81 0	72.9	169	125 6	113 1	229	170 2	153.2	289	214 8	193.4
50	37 2	33.5	110	81 7	73.6	170	126 3	113 8	230	170 9	153.9	290	215 5	194.0
51	37 9	34.1	111	82.5	74.3	171	127 1	114 4	231	171 7	154.6	291	216 3	194.7
52	38 6	34.8	112	83 2	74.9	172	127.8	115 1	232	172 4	155.2	292	217.0	195.4
53	39.4	35.5	113	84 0	75.6	173	128.6	115.8	233	173.2	155.9	293	217.7	196.1
54	40 1	36.1	114	84.7	76.3	174	129 3	116 4	234	173 9	156.6	294	218 5	196.7
55	40 9	36.8	115	85.5	77.0	175	130 1	117 1	235	174 6	157.2	295	219 2	197.4
56	41.6	37.5	116	86 2	77.6	176	130 8	117 8	236	175 4	157.9	296	220 0	198.1
57	42.4	38.1	117	86.9	78.3	177	131 5	118 4	237	176.1	158.6	297	220 7	198.7
58	43 1	38.8	118	87 7	79 0	178	132 3	119.1	238	176 9	159.3	298	221 5	199.4
59	43 8	39.5	119	88.4	79 6	179	133 0	119 8	239	177 6	159.9	299	222 2	200.1
60	44 6	40.1	120	89.1	80 3	180	133.8	120.4	240	178.4	160.6	300	222 9	200.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 42 Degrees]

TABLE II.

59

Difference of Latitude and Departure for 43 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	01.4	01.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	02.1	02.0	63	46.1	43.0	23	90.0	84.0	83	133.8	124.8	43	177.7	165.7
4	02.9	02.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.5	166.4
5	03.7	03.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	04.4	04.1	66	48.3	45.0	26	92.2	85.9	86	136.0	126.9	46	179.9	167.8
7	05.1	04.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.5
8	05.9	05.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	06.6	06.1	69	50.5	47.1	29	94.3	88.0	89	138.2	128.9	49	182.1	169.8
10	07.3	06.8	70	51.2	47.7	30	95.1	88.7	90	139.0	129.6	50	182.8	170.5
11	08.0	07.5	71	51.9	48.4	31	95.8	89.3	91	139.7	130.3	51	183.5	171.2
12	08.8	08.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.9
13	09.5	08.9	73	53.4	49.8	33	97.3	90.7	93	141.2	131.6	53	185.0	172.5
14	10.2	09.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.1	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.8	96	143.3	133.7	56	187.2	174.6
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.4	57	188.0	175.3
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.1	58	188.7	176.0
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.6	40	102.4	95.5	100	146.3	136.4	60	190.2	177.3
21	15.4	14.3	81	59.2	55.2	41	103.1	96.2	101	147.0	137.1	61	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	102	147.7	137.8	62	191.6	178.7
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	103	148.5	138.4	63	192.3	179.4
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	104	149.2	139.1	64	193.1	180.0
25	18.3	17.0	85	62.2	58.0	45	106.0	98.9	105	149.9	139.8	65	193.8	180.7
26	19.0	17.7	86	62.9	58.7	46	106.8	99.6	106	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.3	107	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	108	152.1	141.9	68	196.0	182.8
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	109	152.9	142.5	69	196.7	183.5
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	110	153.6	143.2	70	197.5	184.1
31	22.7	21.1	91	66.6	62.1	51	110.4	103.0	111	154.3	143.9	71	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.7	112	155.0	144.6	72	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	113	155.8	145.3	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	114	156.5	145.9	74	200.4	186.9
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	115	157.2	146.6	75	201.1	187.5
36	26.3	24.6	96	70.2	65.5	56	114.1	106.4	116	158.0	147.3	76	201.9	188.2
37	27.1	25.3	97	70.9	66.2	57	114.8	107.1	117	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.8	118	159.4	148.7	78	203.3	189.6
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	119	160.2	149.4	79	204.0	190.2
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	120	161.0	150.0	80	204.8	191.0
41	30.0	28.0	101	73.9	68.9	61	117.7	109.8	121	161.6	150.7	81	205.5	191.6
42	30.7	28.7	102	74.6	69.6	62	118.5	110.5	122	162.4	151.4	82	206.2	192.3
43	31.4	29.3	103	75.3	70.2	63	119.2	111.2	123	163.1	152.1	83	207.0	193.0
44	32.2	30.0	104	76.1	70.9	64	119.9	111.9	124	163.8	152.8	84	207.7	193.7
45	32.9	30.7	105	76.8	71.6	65	120.7	112.6	125	164.6	153.4	85	208.4	194.4
46	33.6	31.4	106	77.5	72.3	66	121.4	113.2	126	165.3	154.1	86	209.2	195.1
47	34.4	32.1	107	78.3	73.0	67	122.1	113.9	127	166.0	154.8	87	209.9	195.7
48	35.1	32.7	108	79.0	73.7	68	122.9	114.6	128	166.7	155.5	88	210.6	196.4
49	35.8	33.4	109	79.7	74.3	69	123.6	115.3	129	167.5	156.2	89	211.4	197.1
50	36.6	34.1	110	80.4	75.0	70	124.3	115.9	130	168.2	156.9	90	212.1	197.8
51	37.3	34.8	111	81.2	75.7	71	125.1	116.6	131	169.0	157.5	91	212.8	198.5
52	38.0	35.5	112	81.9	76.4	72	125.8	117.3	132	169.7	158.2	92	213.5	199.1
53	38.8	36.1	113	82.6	77.1	73	126.6	118.0	133	170.4	158.9	93	214.3	199.8
54	39.5	36.8	114	83.4	77.7	74	127.3	118.7	134	171.1	159.6	94	215.0	200.5
55	40.2	37.5	115	84.1	78.4	75	128.0	119.3	135	171.9	160.3	95	215.7	201.2
56	41.0	38.2	116	84.8	79.1	76	128.7	120.0	136	172.6	161.0	96	216.5	201.9
57	41.7	38.9	117	85.6	79.8	77	129.5	120.7	137	173.3	161.6	97	217.2	202.6
58	42.4	39.6	118	86.3	80.5	78	130.2	121.4	138	174.1	162.3	98	217.9	203.3
59	43.1	40.2	119	87.0	81.2	79	131.0	122.1	139	174.8	163.0	99	218.7	204.0
60	43.9	40.9	120	87.8	81.8	80	131.6	122.8	140	175.5	163.7	100	219.4	204.6

(For 47 Degrees.)

TABLE II.

Difference of Latitude and Departure for 34 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	02.5	01.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.5	135.9
4	03.3	02.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	04.1	02.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	05.0	03.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	05.8	03.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	06.6	04.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	07.5	05.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	08.3	05.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	07.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	07.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	08.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	08.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	09.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	39	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.6	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	170.0	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.6	47	121.9	82.2	07	171.6	115.8	67	221.4	149.3
28	23.2	15.7	88	73.0	49.2	48	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.8	118.5	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.2	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.2	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.5	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.9	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.3	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.7	132.0	96	245.4	165.5
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.1	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	20	99.5	67.1	80	149.2	100.7	40	199.0	134.2	300	248.7	167.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 56 Degrees.]

TABLE II.

51

Difference of Latitude and Departure for 35 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.0	35.0	121	99.1	69.4	181	148.3	103.0	241	197.4	136.2
2	01.6	01.1	62	50.8	35.6	22	99.9	70.0	82	149.1	104.4	42	198.2	138.8
3	02.3	01.7	63	51.6	36.1	23	100.8	70.5	83	149.9	105.0	43	199.1	139.4
4	03.3	02.3	64	52.4	36.7	24	101.6	71.1	84	150.7	105.8	44	199.9	140.0
5	04.1	02.9	65	53.2	37.3	25	102.4	71.7	85	151.5	106.1	45	200.7	140.5
6	04.9	03.4	66	54.0	37.9	26	103.2	72.3	86	152.4	106.7	46	201.5	141.1
7	05.7	04.0	67	54.9	38.4	27	104.0	72.8	87	153.2	107.3	47	202.3	141.7
8	06.6	04.6	68	55.7	39.0	28	104.9	73.4	88	154.0	107.9	48	203.1	142.2
9	07.4	05.2	69	56.5	39.6	29	105.7	74.0	89	154.8	108.4	49	204.0	142.8
10	08.2	05.7	70	57.3	40.2	30	106.5	74.6	90	155.6	109.0	50	204.8	143.4
11	09.0	06.3	71	58.2	40.7	31	107.3	75.1	91	156.5	109.6	51	205.6	144.0
12	09.8	06.9	72	59.0	41.3	32	108.1	75.7	92	157.3	110.1	52	206.4	144.6
13	10.6	07.5	73	59.9	41.9	33	108.9	76.3	93	158.1	110.7	53	207.2	145.1
14	11.5	08.1	74	60.6	42.4	34	109.8	76.9	94	158.9	111.3	54	208.1	145.7
15	12.3	08.6	75	61.4	43.0	35	110.6	77.4	95	159.7	111.8	55	208.9	146.3
16	13.1	09.2	76	62.3	43.6	36	111.4	78.0	96	160.6	112.4	56	209.7	146.8
17	13.9	09.8	77	63.1	44.2	37	112.2	78.6	97	161.4	113.0	57	210.5	147.4
18	14.7	10.3	78	63.9	44.7	38	113.0	79.2	98	162.2	113.6	58	211.3	148.0
19	15.5	10.9	79	64.7	45.3	39	113.9	79.7	99	163.0	114.1	59	212.2	148.6
20	16.3	11.5	80	65.5	45.8	40	114.7	80.3	200	163.8	114.7	60	213.0	149.1
21	17.2	12.0	81	66.3	46.3	41	115.5	80.9	201	164.6	115.3	61	213.8	149.7
22	18.0	12.6	82	67.2	47.0	42	116.3	81.4	202	165.3	115.9	62	214.6	150.3
23	18.8	13.2	83	68.0	47.5	43	117.1	82.0	203	166.1	116.4	63	215.4	150.9
24	19.7	13.8	84	68.9	48.1	44	118.0	82.6	204	167.1	117.0	64	216.3	151.4
25	20.5	14.3	85	69.6	48.6	45	118.8	83.2	205	167.9	117.6	65	217.1	152.0
26	21.3	14.9	86	70.4	49.1	46	119.6	83.7	206	168.7	118.2	66	217.9	152.6
27	22.1	15.5	87	71.3	49.9	47	120.4	84.3	207	169.6	118.7	67	218.7	153.1
28	22.9	16.1	88	72.1	50.3	48	121.2	84.9	208	170.4	119.3	68	219.5	153.7
29	23.7	16.6	89	72.9	51.0	49	122.1	85.5	209	171.2	119.9	69	220.4	154.3
30	24.5	17.2	90	73.7	51.6	50	122.9	86.0	210	172.0	120.5	70	221.2	154.9
31	25.4	17.8	91	74.5	52.2	51	123.7	86.6	211	172.8	121.0	71	222.0	155.4
32	26.2	18.4	92	75.3	52.7	52	124.5	87.2	212	173.7	121.6	72	222.8	156.0
33	27.0	19.0	93	76.2	53.3	53	125.3	87.8	213	174.5	122.2	73	223.6	156.6
34	27.9	19.5	94	77.0	53.9	54	126.1	88.3	214	175.3	122.7	74	224.4	157.2
35	28.7	20.1	95	77.9	54.5	55	127.0	88.9	215	176.1	123.3	75	225.3	157.7
36	29.5	20.6	96	78.7	55.1	56	127.8	89.5	216	176.9	123.9	76	226.1	158.3
37	30.3	21.2	97	79.5	55.6	57	128.6	90.1	217	177.7	124.5	77	226.9	158.9
38	31.1	21.8	98	80.3	56.2	58	129.4	90.6	218	178.5	125.0	78	227.7	159.5
39	31.9	22.4	99	81.1	56.8	59	130.2	91.2	219	179.3	125.6	79	228.5	160.0
40	32.8	22.9	100	81.9	57.4	60	131.1	91.8	220	180.1	126.2	80	229.3	160.6
41	33.6	23.5	101	82.7	57.9	61	131.9	92.3	221	181.0	126.8	81	230.2	161.2
42	34.4	24.1	102	83.6	58.5	62	132.7	92.9	222	181.9	127.3	82	231.0	161.7
43	35.2	24.7	103	84.4	59.1	63	133.5	93.6	223	182.7	127.9	83	231.8	162.3
44	36.0	25.2	104	85.2	59.7	64	134.3	94.1	224	183.5	128.5	84	232.6	162.9
45	36.9	25.8	105	86.0	60.2	65	135.2	94.6	225	184.3	129.1	85	233.5	163.5
46	37.7	26.4	106	86.8	60.8	66	136.0	95.2	226	185.1	129.6	86	234.3	164.0
47	38.5	27.0	107	87.6	61.4	67	136.8	95.8	227	185.9	130.2	87	235.1	164.6
48	39.3	27.5	108	88.5	61.9	68	137.6	96.4	228	186.8	130.8	88	235.9	165.2
49	40.1	28.1	109	89.3	62.5	69	138.4	96.9	229	187.6	131.3	89	236.7	165.8
50	41.0	28.7	110	90.1	63.1	70	139.3	97.5	230	188.4	131.9	90	237.5	166.3
51	41.8	29.3	111	90.9	63.7	71	140.1	98.1	231	189.2	132.5	91	238.4	166.9
52	42.6	29.8	112	91.7	64.2	72	140.9	98.7	232	190.0	133.1	92	239.2	167.5
53	43.4	30.4	113	92.6	64.8	73	141.7	99.2	233	190.9	133.6	93	240.0	168.1
54	44.2	31.0	114	93.4	65.1	74	142.5	99.8	234	191.7	134.2	94	240.8	168.6
55	45.1	31.5	115	94.2	65.6	75	143.4	100.4	235	192.5	134.8	95	241.6	169.2
56	45.9	32.1	116	95.0	66.3	76	144.2	100.9	236	193.3	135.4	96	242.5	169.8
57	46.7	32.7	117	95.8	67.1	77	145.0	101.5	237	194.1	135.9	97	243.3	170.4
58	47.5	33.3	118	96.7	67.7	78	145.8	102.1	238	195.0	136.5	98	244.1	170.9
59	48.3	33.8	119	97.5	68.3	79	146.6	102.7	239	195.8	137.1	99	244.9	171.5
60	49.1	34.4	120	98.3	68.8	80	147.4	103.2	240	196.6	137.7	200	245.7	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 35 Degrees.)

TABLE II.

55

Difference of Latitude and Departure for 37 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 8	00 6	61	48 7	36 7	121	96 6	72 8	181	144 6	108 9	241	192 5	143 0
2	01 6	01 2	62	49 5	37 3	22	97 4	73 4	82	145 4	109 5	42	193 3	143 6
3	02 4	01 8	63	50 3	37 9	23	98 2	74 0	83	146 2	110 1	43	194 1	146 2
4	03 2	02 4	64	51 1	38 5	24	99 0	74 6	84	147 0	110 7	44	194 9	146 8
5	04 0	03 0	65	51 9	39 1	25	99 8	75 2	85	147 7	111 3	45	195 7	147 4
6	04 8	03 6	66	52 7	39 7	26	100 6	75 8	86	148 5	111 9	46	196 5	148 0
7	05 6	04 2	67	53 5	40 3	27	101 4	76 4	87	149 3	112 5	47	197 3	148 6
8	06 4	04 8	68	54 3	40 9	28	102 2	77 0	88	150 1	113 1	48	198 1	149 3
9	07 2	05 4	69	55 1	41 5	29	103 0	77 6	89	150 9	113 7	49	198 9	149 9
10	08 0	06 0	70	55 9	42 1	30	103 8	78 2	90	151 7	114 3	50	199 7	150 5
11	08 8	06 8	71	56 7	42 7	31	104 6	78 8	91	152 5	114 9	51	200 5	151 1
12	09 6	07 2	72	57 5	43 3	32	105 4	79 4	92	153 3	115 5	52	201 3	151 7
13	10 4	07 8	73	58 3	43 9	33	106 2	80 0	93	154 1	116 1	53	202 1	152 3
14	11 2	08 4	74	59 1	44 5	34	107 0	80 6	94	154 9	116 7	54	202 9	152 9
15	12 0	09 0	75	59 9	45 1	35	107 8	81 2	95	155 7	117 3	55	203 7	153 5
16	12 8	09 6	76	60 7	45 7	36	108 6	81 8	96	156 5	117 9	56	204 5	154 1
17	13 6	10 2	77	61 5	46 3	37	109 4	82 4	97	157 3	118 5	57	205 3	154 7
18	14 4	10 8	78	62 3	46 9	38	110 2	83 0	98	158 1	119 1	58	206 1	155 3
19	15 2	11 4	79	63 1	47 5	39	111 0	83 6	99	158 9	119 7	59	206 9	155 9
20	16 0	12 0	80	63 9	48 1	40	111 8	84 2	200	159 7	120 3	60	207 7	156 5
21	16 8	12 6	81	64 7	48 7	41	112 6	84 8	201	160 5	121 0	61	208 5	157 1
22	17 6	13 2	82	65 5	49 3	42	113 4	85 4	202	161 3	121 6	62	209 3	157 7
23	18 4	13 8	83	66 3	49 9	43	114 2	86 0	203	162 1	122 2	63	210 1	158 3
24	19 2	14 4	84	67 1	50 5	44	115 0	86 6	204	162 9	122 8	64	210 9	158 9
25	20 0	15 0	85	67 9	51 1	45	115 8	87 2	205	163 7	123 4	65	211 7	159 5
26	20 8	15 6	86	68 7	51 7	46	116 6	87 8	206	164 5	124 0	66	212 5	160 1
27	21 6	16 2	87	69 5	52 3	47	117 4	88 4	207	165 3	124 6	67	213 3	160 7
28	22 4	16 8	88	70 3	52 9	48	118 2	89 0	208	166 1	125 2	68	214 1	161 3
29	23 2	17 4	89	71 1	53 5	49	119 0	89 6	209	166 9	125 8	69	214 9	161 9
30	24 0	18 0	90	71 9	54 1	50	119 8	90 2	210	167 7	126 4	70	215 7	162 5
31	24 8	18 6	91	72 7	54 7	51	120 6	90 8	211	168 5	127 0	71	216 5	163 1
32	25 6	19 2	92	73 5	55 3	52	121 4	91 4	212	169 3	127 6	72	217 3	163 7
33	26 4	19 8	93	74 3	55 9	53	122 2	92 0	213	170 1	128 2	73	218 1	164 3
34	27 2	20 4	94	75 1	56 5	54	123 0	92 6	214	170 9	128 8	74	218 9	164 9
35	28 0	21 0	95	75 9	57 1	55	123 8	93 2	215	171 7	129 4	75	219 7	165 5
36	28 8	21 6	96	76 7	57 7	56	124 6	93 8	216	172 5	130 0	76	220 5	166 1
37	29 6	22 2	97	77 5	58 3	57	125 4	94 4	217	173 3	130 6	77	221 3	166 7
38	30 4	22 8	98	78 3	58 9	58	126 2	95 0	218	174 1	131 2	78	222 1	167 3
39	31 2	23 4	99	79 1	59 5	59	127 0	95 6	219	174 9	131 8	79	222 9	167 9
40	32 0	24 0	100	79 9	60 1	60	127 8	96 2	220	175 7	132 4	80	223 7	168 5
41	32 8	24 6	101	80 7	60 7	61	128 6	96 8	221	176 5	133 0	81	224 5	169 1
42	33 6	25 2	102	81 5	61 3	62	129 4	97 4	222	177 3	133 6	82	225 3	169 7
43	34 4	25 8	103	82 3	61 9	63	130 2	98 0	223	178 1	134 2	83	226 1	170 3
44	35 2	26 4	104	83 1	62 5	64	131 0	98 6	224	178 9	134 8	84	226 9	170 9
45	36 0	27 0	105	83 9	63 1	65	131 8	99 2	225	179 7	135 4	85	227 7	171 5
46	36 8	27 6	106	84 7	63 7	66	132 6	99 8	226	180 5	136 0	86	228 5	172 1
47	37 6	28 2	107	85 5	64 3	67	133 4	100 4	227	181 3	136 6	87	229 3	172 7
48	38 4	28 8	108	86 3	64 9	68	134 2	101 0	228	182 1	137 2	88	230 1	173 3
49	39 2	29 4	109	87 1	65 5	69	135 0	101 6	229	182 9	137 8	89	230 9	173 9
50	40 0	30 0	110	87 9	66 1	70	135 8	102 2	230	183 7	138 4	90	231 7	174 5
51	40 8	30 6	111	88 7	66 7	71	136 6	102 8	231	184 5	139 0	91	232 5	175 1
52	41 6	31 2	112	89 5	67 3	72	137 4	103 4	232	185 3	139 6	92	233 3	175 7
53	42 4	31 8	113	90 3	67 9	73	138 2	104 0	233	186 1	140 2	93	234 1	176 3
54	43 2	32 4	114	91 1	68 5	74	139 0	104 6	234	186 9	140 8	94	234 9	176 9
55	44 0	33 0	115	91 9	69 1	75	139 8	105 2	235	187 7	141 4	95	235 7	177 5
56	44 8	33 6	116	92 7	69 7	76	140 6	105 8	236	188 5	142 0	96	236 5	178 1
57	45 6	34 2	117	93 5	70 3	77	141 4	106 4	237	189 3	142 6	97	237 3	178 7
58	46 4	34 8	118	94 3	70 9	78	142 2	107 0	238	190 1	143 2	98	238 1	179 3
59	47 2	35 4	119	95 1	71 5	79	143 0	107 6	239	190 9	143 8	99	238 9	179 9
60	48 0	36 0	120	95 9	72 1	80	143 8	108 2	240	191 7	144 4	300	239 7	180 5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 33 Degrees.)

TABLE II.

55

Difference of Latitude and Departure for 39 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	122	94.8	76.8	182	141.4	114.5	242	188.1	152.3
3	02.3	01.9	63	49.0	39.6	123	95.6	77.4	183	142.2	115.2	243	188.8	152.9
4	03.1	02.5	64	49.7	40.3	124	96.4	78.0	184	143.0	115.8	244	189.6	153.6
5	03.9	03.1	65	50.5	40.9	125	97.1	78.7	185	143.8	116.4	245	190.4	154.2
6	04.7	03.8	66	51.3	41.5	126	97.9	79.3	186	144.5	117.1	246	191.2	154.8
7	05.4	04.4	67	52.1	42.2	127	98.7	79.9	187	145.3	117.7	247	192.0	155.4
8	06.2	05.0	68	52.8	42.8	128	99.5	80.6	188	146.1	118.3	248	192.7	156.1
9	07.0	05.7	69	53.6	43.4	129	100.3	81.2	189	146.9	118.9	249	193.5	156.7
10	07.8	06.3	70	54.4	44.1	130	101.0	81.8	190	147.7	119.6	250	194.3	157.3
11	08.5	06.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	09.3	07.6	72	56.0	45.3	132	102.6	83.1	192	149.2	120.8	252	195.8	158.6
13	10.1	08.2	73	56.7	45.9	133	103.4	83.7	193	150.0	121.5	253	196.6	159.2
14	10.9	08.8	74	57.5	46.6	134	104.1	84.3	194	150.8	122.1	254	197.4	159.8
15	11.7	09.4	75	58.3	47.2	135	104.9	85.0	195	151.5	122.7	255	198.2	160.5
16	12.4	10.1	76	59.1	47.8	136	105.7	85.6	196	152.3	123.3	256	198.9	161.1
17	13.2	10.7	77	59.8	48.5	137	106.5	86.2	197	153.1	124.0	257	199.7	161.7
18	14.0	11.3	78	60.6	49.1	138	107.2	86.8	198	153.9	124.6	258	200.5	162.4
19	14.8	12.0	79	61.4	49.7	139	108.0	87.5	199	154.7	125.2	259	201.3	163.0
20	15.5	12.6	80	62.2	50.3	140	108.8	88.1	200	155.4	125.9	260	202.1	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.3
22	17.1	13.8	82	63.7	51.6	142	110.4	89.4	202	157.0	127.1	262	203.6	164.9
23	17.9	14.5	83	64.5	52.2	143	111.1	90.0	203	157.8	127.8	263	204.4	165.5
24	18.7	15.1	84	65.3	52.9	144	111.9	90.6	204	158.6	128.4	264	205.2	166.1
25	19.4	15.7	85	66.1	53.5	145	112.7	91.3	205	159.3	129.0	265	205.9	166.8
26	20.2	16.4	86	66.8	54.1	146	113.5	91.9	206	160.1	129.6	266	206.7	167.4
27	21.0	17.0	87	67.6	54.8	147	114.2	92.5	207	160.9	130.3	267	207.5	168.0
28	21.8	17.6	88	68.4	55.4	148	115.0	93.1	208	161.6	130.9	268	208.3	168.7
29	22.5	18.3	89	69.2	56.0	149	115.8	93.8	209	162.4	131.5	269	209.1	169.3
30	23.3	18.9	90	69.9	56.6	150	116.6	94.4	210	163.2	132.2	270	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	152	118.1	95.7	212	164.8	133.4	272	211.4	171.2
33	25.6	20.8	93	72.3	58.5	153	118.9	96.3	213	165.5	134.0	273	212.2	171.8
34	26.4	21.4	94	73.1	59.2	154	119.7	96.9	214	166.3	134.7	274	212.9	172.4
35	27.2	22.0	95	73.8	59.8	155	120.5	97.5	215	167.1	135.3	275	213.7	173.1
36	28.0	22.7	96	74.6	60.4	156	121.2	98.2	216	167.9	135.9	276	214.5	173.7
37	28.8	23.3	97	75.4	61.0	157	122.0	98.8	217	168.6	136.6	277	215.3	174.3
38	29.5	23.9	98	76.2	61.7	158	122.8	99.4	218	169.4	137.2	278	216.0	175.0
39	30.3	24.5	99	76.9	62.3	159	123.6	100.1	219	170.2	137.8	279	216.8	175.6
40	31.1	25.2	100	77.7	62.9	160	124.3	100.7	220	171.0	138.5	280	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	102	79.3	64.2	162	125.9	101.9	222	172.5	139.7	282	219.2	177.5
43	33.4	27.1	103	80.0	64.8	163	126.7	102.6	223	173.3	140.3	283	219.9	178.1
44	34.2	27.7	104	80.8	65.4	164	127.5	103.2	224	174.1	141.0	284	220.7	178.7
45	35.0	28.3	105	81.6	66.1	165	128.2	103.8	225	174.9	141.6	285	221.5	179.4
46	35.7	28.9	106	82.4	66.7	166	129.0	104.5	226	175.6	142.2	286	222.3	180.0
47	36.5	29.6	107	83.2	67.3	167	129.8	105.1	227	176.4	142.9	287	223.0	180.6
48	37.3	30.2	108	83.9	68.0	168	130.6	105.7	228	177.2	143.5	288	223.8	181.2
49	38.1	30.8	109	84.7	68.6	169	131.3	106.4	229	178.0	144.1	289	224.6	181.9
50	38.9	31.5	110	85.5	69.2	170	132.1	107.0	230	178.7	144.7	290	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	112	87.0	70.5	172	133.7	108.2	232	180.3	146.0	292	226.9	183.8
53	41.2	33.4	113	87.8	71.1	173	134.4	108.9	233	181.1	146.6	293	227.7	184.4
54	42.0	34.0	114	88.6	71.7	174	135.2	109.5	234	181.9	147.3	294	228.5	185.0
55	42.7	34.6	115	89.4	72.4	175	136.0	110.1	235	182.6	147.9	295	229.3	185.6
56	43.5	35.2	116	90.1	73.0	176	136.8	110.8	236	183.4	148.5	296	230.0	186.3
57	44.3	35.9	117	90.9	73.6	177	137.5	111.4	237	184.2	149.1	297	230.8	186.9
58	45.1	36.5	118	91.7	74.3	178	138.3	112.0	238	185.0	149.8	298	231.6	187.5
59	45.9	37.1	119	92.5	74.9	179	139.1	112.6	239	185.7	150.4	299	232.4	188.2
60	46.6	37.8	120	93.3	75.5	180	139.9	113.2	240	186.5	151.0	300	233.1	188.8

[For 51 Degrees.]

Difference of Latitude and Departure for 40 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.2	00.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	241	184.6	154.9
2	01.5	01.3	62	47.8	39.9	122	93.8	78.4	182	139.4	117.0	242	185.4	155.6
3	02.3	01.9	63	48.3	40.8	123	94.2	79.1	183	140.2	117.6	243	186.1	156.2
4	03.1	02.6	64	49.0	41.1	124	95.0	79.7	184	141.0	118.3	244	186.9	156.8
5	03.8	03.2	65	49.8	41.8	125	95.8	80.3	185	141.7	118.9	245	187.7	157.5
6	04.6	03.9	66	50.6	42.4	126	96.5	81.0	186	142.5	119.6	246	188.4	158.1
7	05.4	04.5	67	51.3	43.1	127	97.3	81.6	187	143.3	120.2	247	189.2	158.8
8	06.1	05.1	68	52.1	43.7	128	98.1	82.3	188	144.0	120.8	248	190.0	159.4
9	06.9	05.8	69	52.9	44.4	129	98.8	82.9	189	144.8	121.5	249	190.7	160.1
10	07.7	06.4	70	53.6	45.0	130	99.6	83.6	190	145.5	122.1	250	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	09.2	07.7	72	55.2	46.3	132	101.1	84.8	192	147.1	123.4	252	193.0	162.0
13	10.0	08.4	73	56.0	46.9	133	101.9	85.5	193	147.8	124.1	253	193.8	162.6
14	10.7	09.0	74	56.7	47.6	134	102.6	86.1	194	148.6	124.7	254	194.6	163.3
15	11.5	09.6	75	57.5	48.2	135	103.4	86.8	195	149.4	125.3	255	195.4	163.9
16	12.3	10.3	76	58.2	48.9	136	104.2	87.4	196	150.1	126.0	256	196.2	164.6
17	13.0	10.9	77	59.0	49.5	137	104.9	88.1	197	150.9	126.6	257	197.0	165.2
18	13.8	11.6	78	59.8	50.1	138	105.7	88.7	198	151.7	127.3	258	197.8	165.8
19	14.6	12.2	79	60.5	50.8	139	106.5	89.3	199	152.4	127.9	259	198.6	166.5
20	15.3	12.9	80	61.3	51.4	140	107.2	90.0	200	153.2	128.5	260	199.4	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	142	108.8	91.3	202	154.7	129.8	262	200.7	168.4
23	17.6	14.8	83	63.6	53.4	143	109.5	91.9	203	155.5	130.5	263	201.5	169.1
24	18.4	15.4	84	64.3	54.0	144	110.3	92.6	204	156.3	131.1	264	202.3	169.7
25	19.2	16.1	85	65.1	54.6	145	111.1	93.2	205	157.1	131.8	265	203.1	170.3
26	19.9	16.7	86	65.9	55.3	146	111.8	93.8	206	157.9	132.4	266	203.9	171.0
27	20.7	17.4	87	66.6	55.9	147	112.6	94.5	207	158.6	133.1	267	204.7	171.6
28	21.4	18.0	88	67.4	56.6	148	113.4	95.1	208	159.4	133.7	268	205.5	172.3
29	22.2	18.6	89	68.2	57.2	149	114.1	95.8	209	160.2	134.3	269	206.3	172.9
30	23.0	19.3	90	68.9	57.9	150	114.9	96.4	210	161.0	135.0	270	207.1	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.8	135.6	271	207.9	174.2
32	24.5	20.6	92	70.5	59.1	152	116.4	97.7	212	162.6	136.3	272	208.7	174.8
33	25.3	21.2	93	71.2	59.8	153	117.2	98.3	213	163.4	136.9	273	209.5	175.5
34	26.0	21.9	94	72.0	60.4	154	118.0	99.0	214	164.2	137.5	274	210.3	176.1
35	26.8	22.5	95	72.8	61.1	155	118.7	99.6	215	165.0	138.2	275	211.1	176.8
36	27.6	23.1	96	73.5	61.7	156	119.5	100.3	216	165.8	138.8	276	211.9	177.4
37	28.3	23.8	97	74.3	62.4	157	120.3	100.9	217	166.6	139.5	277	212.7	178.1
38	29.1	24.4	98	75.1	63.0	158	121.0	101.6	218	167.4	140.1	278	213.5	178.7
39	29.9	25.1	99	75.8	63.6	159	121.8	102.2	219	168.2	140.8	279	214.3	179.3
40	30.6	25.7	100	76.6	64.3	160	122.6	102.8	220	169.0	141.4	280	215.1	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.8	142.1	281	215.9	180.6
42	32.2	27.0	102	78.1	65.6	162	124.1	104.1	222	170.6	142.7	282	216.7	181.3
43	32.9	27.6	103	78.9	66.2	163	124.9	104.8	223	171.4	143.3	283	217.5	181.9
44	33.7	28.3	104	79.7	66.8	164	125.6	105.4	224	172.2	144.0	284	218.3	182.6
45	34.5	28.9	105	80.4	67.5	165	126.4	106.1	225	173.0	144.6	285	219.1	183.2
46	35.3	29.6	106	81.2	68.1	166	127.2	106.7	226	173.8	145.3	286	219.9	183.8
47	36.0	30.2	107	82.0	68.8	167	127.9	107.3	227	174.6	145.9	287	220.7	184.5
48	36.8	30.9	108	82.7	69.4	168	128.7	108.0	228	175.4	146.6	288	221.5	185.1
49	37.6	31.5	109	83.5	70.1	169	129.5	108.6	229	176.2	147.2	289	222.3	185.8
50	38.3	32.1	110	84.3	70.7	170	130.3	109.3	230	177.0	147.9	290	223.1	186.4
51	39.1	32.8	111	85.0	71.3	171	131.0	109.9	231	177.8	148.5	291	223.9	187.1
52	39.8	33.4	112	85.8	72.0	172	131.8	110.6	232	178.6	149.1	292	224.7	187.7
53	40.6	34.1	113	86.6	72.6	173	132.6	111.2	233	179.4	149.8	293	225.5	188.3
54	41.4	34.7	114	87.3	73.3	174	133.3	111.8	234	180.2	150.4	294	226.3	189.0
55	42.1	35.4	115	88.1	73.9	175	134.1	112.5	235	181.0	151.1	295	227.1	189.6
56	42.9	36.0	116	88.9	74.6	176	134.8	113.1	236	181.8	151.7	296	227.9	190.3
57	43.7	36.6	117	89.7	75.2	177	135.6	113.8	237	182.6	152.3	297	228.7	190.9
58	44.4	37.3	118	90.4	75.8	178	136.4	114.4	238	183.4	153.0	298	229.5	191.6
59	45.2	37.9	119	91.2	76.5	179	137.2	115.1	239	184.2	153.6	299	230.3	192.2
60	46.0	38.6	120	91.9	77.1	180	137.9	115.7	240	185.0	154.3	300	231.1	192.8

[For 50 Degrees.]

TABLE II.

Difference of Latitude and Departure for 41 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.3	01.3	62	46.8	40.7	122	92.1	80.0	82	137.4	119.4	42	182.6	158.8
3	01.8	02.0	63	47.5	41.3	123	92.8	80.7	83	138.1	120.1	43	183.4	159.4
4	02.3	02.6	64	48.3	42.0	124	93.6	81.4	84	138.9	120.7	44	184.1	160.1
5	02.8	03.3	65	49.1	42.6	125	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	03.3	03.9	66	49.8	43.3	126	95.1	82.7	86	140.4	122.0	46	185.7	161.4
7	03.8	04.6	67	50.6	44.0	127	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	04.3	05.2	68	51.3	44.6	128	96.6	84.0	88	141.9	123.3	48	187.2	162.7
9	04.8	05.9	69	52.1	45.3	129	97.4	84.6	89	142.6	124.0	49	187.9	163.4
10	05.3	06.6	70	52.8	45.9	130	98.1	85.3	90	143.4	124.7	50	188.7	164.0
11	05.8	07.2	71	53.6	46.6	131	98.9	85.9	191	144.1	125.3	251	189.4	164.7
12	06.3	07.9	72	54.3	47.2	132	99.6	86.6	92	144.9	126.0	52	190.2	165.3
13	06.8	08.5	73	55.1	47.9	133	100.4	87.3	93	145.7	126.6	53	190.9	166.0
14	07.3	09.2	74	55.8	48.5	134	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	07.8	09.8	75	56.6	49.2	135	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	08.3	10.5	76	57.4	49.9	136	102.6	89.2	96	147.9	128.6	56	193.2	168.0
17	08.8	11.2	77	58.1	50.5	137	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	09.3	11.8	78	58.9	51.2	138	104.1	90.5	98	149.4	129.9	58	194.7	169.3
19	09.8	12.5	79	59.6	51.8	139	104.9	91.2	99	150.2	130.6	59	195.5	169.9
20	10.3	13.1	80	60.4	52.5	140	105.7	91.8	200	150.9	131.2	60	196.2	170.6
21	10.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.9	261	197.0	171.2
22	11.3	14.4	82	61.9	53.7	142	107.2	93.2	02	152.5	132.5	62	197.7	171.9
23	11.8	15.1	83	62.6	54.5	143	107.9	93.8	03	153.2	133.2	63	198.5	172.5
24	12.3	15.7	84	63.4	55.1	144	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	12.8	16.4	85	64.2	55.8	145	109.4	95.1	05	154.7	134.5	65	200.0	173.9
26	13.3	17.1	86	64.9	56.4	146	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	13.8	17.7	87	65.7	57.1	147	110.9	96.4	07	156.2	135.8	67	201.5	175.2
28	14.3	18.4	88	66.4	57.7	148	111.7	97.1	08	157.0	136.5	68	202.3	175.8
29	14.8	19.0	89	67.2	58.4	149	112.5	97.8	09	157.7	137.1	69	203.0	176.5
30	15.3	19.7	90	67.9	59.0	150	113.2	98.4	10	158.5	137.8	70	203.8	177.1
31	15.8	20.3	91	68.7	59.7	151	114.0	99.1	11	159.2	138.4	271	204.5	177.8
32	16.3	21.0	92	69.4	60.4	152	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	16.8	21.6	93	70.2	61.0	153	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	17.3	22.3	94	70.9	61.7	154	116.2	101.0	14	161.5	140.4	74	206.8	179.8
35	17.8	22.9	95	71.7	62.3	155	117.0	101.7	15	162.3	141.1	75	207.5	180.4
36	18.3	23.6	96	72.5	63.0	156	117.7	102.3	16	163.0	141.7	76	208.3	181.1
37	18.8	24.3	97	73.2	63.6	157	118.5	103.0	17	163.8	142.4	77	209.1	181.7
38	19.3	24.9	98	74.0	64.3	158	119.2	103.7	18	164.5	143.0	78	209.8	182.4
39	19.8	25.6	99	74.7	64.9	159	120.0	104.3	19	165.3	143.7	79	210.6	183.0
40	20.3	26.2	100	75.5	65.6	160	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	20.8	26.9	101	76.2	66.3	161	121.5	105.6	21	166.8	145.0	281	212.1	184.4
42	21.3	27.6	02	77.0	66.9	162	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	21.8	28.3	03	77.7	67.6	163	123.0	106.9	23	168.3	146.3	83	213.6	185.7
44	22.3	28.9	04	78.5	68.2	164	123.8	107.6	24	169.1	147.0	84	214.3	186.3
45	22.8	29.6	05	79.2	68.9	165	124.5	108.2	25	169.8	147.6	85	215.1	187.0
46	23.3	30.3	06	80.0	69.5	166	125.3	108.9	26	170.6	148.3	86	215.8	187.6
47	23.8	30.9	07	80.8	70.2	167	126.0	109.6	27	171.3	148.9	87	216.6	188.3
48	24.3	31.6	08	81.5	70.9	168	126.8	110.2	28	172.1	149.6	88	217.4	188.9
49	24.8	32.3	09	82.3	71.5	169	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	25.3	32.9	10	83.0	72.2	170	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	25.8	33.6	11	83.8	72.8	171	129.1	112.2	31	174.3	151.5	291	219.6	190.9
52	26.3	34.3	12	84.5	73.5	172	129.8	112.8	32	175.1	152.2	92	220.4	191.6
53	26.8	34.9	13	85.3	74.1	173	130.6	113.5	33	175.8	152.9	93	221.1	192.2
54	27.3	35.6	14	86.0	74.8	174	131.3	114.2	34	176.6	153.5	94	221.9	192.9
55	27.8	36.3	15	86.8	75.4	175	132.1	114.8	35	177.4	154.2	95	222.6	193.5
56	28.3	36.9	16	87.5	76.1	176	132.8	115.5	36	178.1	154.8	96	223.4	194.2
57	28.8	37.6	17	88.3	76.8	177	133.6	116.1	37	178.9	155.5	97	224.1	194.8
58	29.3	38.3	18	89.1	77.4	178	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	29.8	38.9	19	89.8	78.1	179	135.1	117.4	39	180.4	156.8	99	225.7	196.2
60	30.3	39.6	20	90.6	78.7	180	135.8	118.1	40	181.1	157.5	300	226.4	196.8
Lat.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 49 Degrees.

TABLE II.

Difference of Latitude and Departure for 42 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00 7	00 7	61	45 3	40.8	121	89 9	81 0	181	134 5	121 1	241	179 1	161 3
2	01 5	01 3	62	46 1	41 5	22	90 7	81 6	82	135 3	121 8	42	179 8	161 9
3	02 2	02 0	63	46 8	42 2	23	91 4	82 3	83	136 0	122 5	43	180 6	162 6
4	03 0	02 7	64	47 6	42 8	24	92 1	83 0	84	136 7	123 1	44	181 3	163 3
5	03 7	03 3	65	48 3	43 5	25	92 9	83 6	85	137 5	123 8	45	182 1	163 9
6	04 5	04 0	66	49 0	44 2	26	93 6	84 3	86	138 2	124 5	46	182 8	164 6
7	05 2	04 7	67	49 8	44 8	27	94 4	85 0	87	139 0	125 1	47	183 5	165 3
8	05 9	05 4	68	50 5	45 5	28	95 1	85 6	88	139 7	125 8	48	184 3	165 9
9	06 7	06 0	69	51 3	46 2	29	95 9	86 3	89	140 5	126 5	49	185 0	166 6
10	07 4	06 7	70	52 0	46 8	30	96 6	87 0	90	141 2	127 1	50	185 8	167 3
11	08 2	07 4	71	52 8	47 5	131	97 4	87 7	191	141 9	127 8	261	186 5	168 0
12	08 9	08 0	72	53 5	48 2	32	98 1	88 3	92	142 7	128 5	62	187 3	168 6
13	09 7	08 7	73	54 2	48 8	33	98 8	89 0	93	143 4	129 1	63	188 0	169 3
14	10 4	09 4	74	55 0	49 5	34	99 6	89 7	94	144 2	129 8	64	188 8	170 0
15	11 1	10 0	75	55 7	50 2	35	100 3	90 3	95	144 9	130 5	65	189 5	170 6
16	11 9	10 7	76	56 5	50 9	36	101 1	91 0	96	145 7	131 1	66	190 2	171 3
17	12 6	11 4	77	57 2	51 5	37	101 8	91 7	97	146 4	131 8	67	191 0	172 0
18	13 4	12 0	78	58 0	52 2	38	102 6	92 3	98	147 1	132 5	68	191 7	172 6
19	14 1	12 7	79	58 7	52 9	39	103 3	93 0	99	147 9	133 2	69	192 5	173 3
20	14 9	13 4	80	59 5	53 5	40	104 0	93 7	200	148 6	133 8	60	193 2	174 0
21	15 6	14 1	81	60 2	54 2	141	104 8	94 3	201	149 4	134 5	261	194 0	174 6
22	16 3	14 7	82	60 9	54 9	42	105 5	95 0	02	150 1	135 2	62	194 7	175 3
23	17 1	15 4	83	61 7	55 5	43	106 3	95 7	03	150 9	135 8	63	195 4	176 0
24	17 8	16 1	84	62 4	56 2	44	107 0	96 4	04	151 6	136 5	64	196 2	176 7
25	18 6	16 7	85	63 2	56 9	45	107 8	97 0	05	152 3	137 2	65	196 9	177 3
26	19 3	17 4	86	63 9	57 5	46	108 5	97 7	06	153 1	137 8	66	197 7	178 0
27	20 1	18 1	87	64 7	58 2	47	109 2	98 4	07	153 8	138 5	67	198 4	178 7
28	20 8	18 7	88	65 4	58 9	48	110 0	99 0	08	154 6	139 2	68	199 2	179 3
29	21 6	19 4	89	66 1	59 6	49	110 7	99 7	09	155 3	139 9	69	199 9	180 0
30	22 3	20 1	90	66 9	60 2	50	111 5	100 4	10	156 1	140 5	70	200 6	180 7
31	23 0	20 7	91	67 6	60 9	151	112 2	101 0	211	156 8	141 2	271	201 4	181 3
32	23 8	21 4	92	68 4	61 6	62	113 0	101 7	12	157 5	141 9	72	202 1	182 0
33	24 5	22 1	93	69 1	62 2	63	113 7	102 4	13	158 3	142 5	73	202 9	182 7
34	25 3	22 8	94	69 9	62 9	64	114 4	103 0	14	159 0	143 2	74	203 6	183 3
35	26 0	23 4	95	70 6	63 6	65	115 2	103 7	15	159 8	143 9	75	204 4	184 0
36	26 8	24 1	96	71 3	64 2	66	115 9	104 4	16	160 5	144 5	76	205 1	184 7
37	27 5	24 8	97	72 1	64 9	67	116 7	105 1	17	161 3	145 2	77	205 9	185 4
38	28 2	25 4	98	72 8	65 5	68	117 4	105 7	18	162 0	145 9	78	206 6	186 0
39	29 0	26 1	99	73 6	66 2	69	118 2	106 4	19	162 7	146 5	79	207 3	186 7
40	29 7	26 8	100	73 3	66 9	70	118 9	107 1	20	163 5	147 2	80	208 1	187 4
41	30 5	27 4	101	74 1	67 6	161	119 6	107 7	221	164 2	147 9	281	208 8	188 0
42	31 2	28 1	02	75 8	68 3	62	120 4	108 4	22	165 0	148 5	82	209 6	188 7
43	32 0	28 8	03	76 5	68 9	63	121 1	109 1	23	165 7	149 2	83	210 3	189 4
44	32 7	29 4	04	77 3	69 6	64	121 9	109 7	24	166 5	149 9	84	211 1	190 0
45	33 4	30 1	05	78 0	70 3	65	122 6	110 4	25	167 2	150 6	85	211 8	190 7
46	34 2	30 8	06	78 8	70 9	66	123 4	111 1	26	168 0	151 2	86	212 5	191 4
47	34 9	31 4	07	79 5	71 6	67	124 1	111 7	27	168 7	151 9	87	213 3	192 0
48	35 7	32 1	08	80 3	72 3	68	124 8	112 4	28	169 4	152 6	88	214 0	192 7
49	36 4	32 8	09	81 0	72 9	69	125 6	113 1	29	170 2	153 2	89	214 8	193 4
50	37 2	33 5	10	81 7	73 6	70	126 3	113 8	30	170 9	153 9	90	215 5	194 0
51	37 9	34 1	111	82 5	74 3	171	127 1	114 4	231	171 7	154 6	291	216 3	194 7
52	38 6	34 8	12	83 2	74 9	72	127 8	115 1	32	172 4	155 2	92	217 0	195 4
53	39 4	35 5	13	84 0	75 6	73	128 6	115 8	33	173 2	155 9	93	217 7	196 1
54	40 1	36 1	14	84 7	76 3	74	129 3	116 4	34	173 9	156 6	94	218 5	196 7
55	40 9	36 8	15	85 5	77 0	75	130 1	117 1	35	174 6	157 2	95	219 2	197 4
56	41 6	37 5	16	86 2	77 6	76	130 8	117 8	36	175 4	157 9	96	219 9	198 1
57	42 4	38 1	17	86 9	78 3	77	131 6	118 4	37	176 1	158 6	97	220 7	198 7
58	43 1	38 8	18	87 7	79 0	78	132 3	119 1	38	176 9	159 3	98	221 5	199 4
59	43 8	39 5	19	88 4	79 6	79	133 0	119 8	39	177 6	159 9	99	222 2	200 1
60	44 6	40 1	20	89 2	80 3	80	133 8	120 4	40	178 4	160 6	300	222 9	200 7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 42 Degrees.]

TABLE II.

Difference of Latitude and Departure for 43 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	01.4	01.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	02.2	02.0	63	46.1	43.0	23	90.0	83.9	83	133.8	124.8	43	177.7	165.7
4	02.9	02.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.5	166.4
5	03.7	03.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	04.4	04.1	66	48.3	45.0	26	92.2	85.9	86	136.0	126.9	46	179.9	167.8
7	05.1	04.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.5
8	05.9	05.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	06.6	06.1	69	50.5	47.1	29	94.3	88.0	89	138.3	128.9	49	182.1	169.8
10	07.3	06.8	70	51.2	47.7	30	95.1	88.7	90	139.0	129.6	50	182.8	170.5
11	08.0	07.5	71	51.9	48.4	31	95.8	89.3	91	139.7	130.3	51	183.6	171.2
12	08.8	08.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.9
13	09.5	08.9	73	53.4	49.8	33	97.3	90.7	93	141.2	131.6	53	185.0	172.5
14	10.2	09.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.1	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.8	96	143.3	133.7	56	187.2	174.6
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.4	57	188.0	175.3
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.0	58	188.7	176.0
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.6	40	102.4	95.5	100	146.3	136.4	60	190.2	177.3
21	15.4	14.3	81	59.2	55.2	41	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	02	147.7	137.8	62	191.6	178.7
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	03	148.5	138.4	63	192.3	179.4
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	04	149.2	139.1	64	193.1	180.0
25	18.3	17.0	85	62.2	58.0	45	106.0	98.9	05	149.9	139.8	65	193.8	180.7
26	19.0	17.7	86	62.9	58.7	46	106.8	99.6	06	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.3	07	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	08	152.1	141.9	68	196.0	182.8
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	09	152.9	142.5	69	196.7	183.5
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	10	153.6	143.2	70	197.5	184.1
31	22.7	21.1	91	66.6	62.1	51	110.4	103.0	211	154.3	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.7	12	155.0	144.6	62	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	13	155.8	145.3	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	14	156.5	145.9	74	200.4	186.9
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	15	157.2	146.6	75	201.1	187.5
36	26.3	24.6	96	70.2	65.5	56	114.1	106.4	16	158.0	147.3	76	201.9	188.2
37	27.1	25.2	97	70.9	66.2	57	114.8	107.1	17	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.8	18	159.4	148.7	78	203.3	189.6
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	19	160.2	149.4	79	204.0	190.3
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	20	160.9	150.0	80	204.8	191.0
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	211	161.6	150.7	281	205.5	191.6
42	30.7	28.6	02	74.6	69.6	62	118.5	110.5	22	162.4	151.4	82	206.2	192.3
43	31.4	29.3	03	75.3	70.2	63	119.2	111.2	23	163.1	152.1	83	207.0	193.0
44	32.2	30.0	04	76.1	70.9	64	119.9	111.8	24	163.8	152.8	84	207.7	193.7
45	32.9	30.7	05	76.8	71.6	65	120.7	112.5	25	164.6	153.4	85	208.4	194.4
46	33.6	31.4	06	77.5	72.3	66	121.4	113.2	26	165.3	154.1	86	209.1	195.1
47	34.4	32.1	07	78.3	73.0	67	122.1	113.9	27	166.0	154.8	87	209.9	195.7
48	35.1	32.7	08	79.0	73.7	68	122.9	114.6	28	166.7	155.5	88	210.6	196.4
49	35.8	33.4	09	79.7	74.3	69	123.6	115.3	29	167.5	156.2	89	211.4	197.1
50	36.6	34.1	10	80.4	75.0	70	124.3	115.9	30	168.2	156.9	90	212.1	197.8
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.5
52	38.0	35.5	12	81.9	76.4	72	125.8	117.3	32	169.7	158.2	92	213.6	199.1
53	38.8	36.1	13	82.6	77.1	73	126.5	118.0	33	170.4	158.9	93	214.3	199.8
54	39.5	36.8	14	83.4	77.7	74	127.3	118.7	34	171.1	159.6	94	215.0	200.5
55	40.2	37.5	15	84.1	78.4	75	128.0	119.3	35	171.9	160.3	95	215.7	201.2
56	41.0	38.2	16	84.8	79.1	76	128.7	120.0	36	172.6	161.0	96	216.4	201.9
57	41.7	38.9	17	85.6	79.8	77	129.4	120.7	37	173.3	161.6	97	217.2	202.6
58	42.4	39.6	18	86.3	80.5	78	130.1	121.4	38	174.1	162.3	98	217.9	203.2
59	43.1	40.2	19	87.0	81.2	79	130.9	122.1	39	174.8	163.0	99	218.7	203.9
60	43.9	40.9	20	87.8	81.8	80	131.6	122.8	40	175.5	163.7	300	219.4	204.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 47 Degrees.)

TABLE II.

Difference of Latitude and Departure for 44 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.9	42.4	121	87.0	84.1	181	130.2	125.7	241	173.4	167.4
2	01.4	01.4	62	44.6	43.1	22	87.8	84.7	82	130.9	126.4	42	174.1	168.1
3	02.2	02.1	63	45.3	43.8	23	88.5	85.4	83	131.6	127.1	43	174.8	168.8
4	02.9	02.8	64	46.0	44.5	24	89.2	86.1	84	132.4	127.8	44	175.5	169.5
5	03.6	03.5	65	46.8	45.2	25	89.9	86.8	85	133.1	128.5	45	176.2	170.2
6	04.3	04.2	66	47.5	45.8	26	90.6	87.5	86	133.8	129.2	46	177.0	170.9
7	05.0	04.9	67	48.2	46.5	27	91.4	88.2	87	134.5	129.9	47	177.7	171.6
8	05.8	05.6	68	48.9	47.2	28	92.1	88.9	88	135.2	130.6	48	178.4	172.3
9	06.5	06.3	69	49.6	47.9	29	92.8	89.6	89	136.0	131.3	49	179.1	173.0
10	07.2	06.9	70	50.4	48.6	30	93.5	90.3	90	136.7	132.0	50	179.8	173.7
11	07.9	07.6	71	51.1	49.3	31	94.2	91.0	91	137.4	132.7	51	180.6	174.4
12	08.6	08.3	72	51.8	50.0	32	95.0	91.7	92	138.1	133.4	52	181.3	175.1
13	09.4	09.0	73	52.5	50.7	33	95.7	92.4	93	138.8	134.1	53	182.0	175.7
14	10.1	09.7	74	53.2	51.4	34	96.4	93.1	94	139.6	134.8	54	182.7	176.4
15	10.8	10.4	75	54.0	52.1	35	97.1	93.8	95	140.3	135.5	55	183.4	177.1
16	11.5	11.1	76	54.7	52.8	36	97.8	94.5	96	141.0	136.2	56	184.2	177.8
17	12.2	11.8	77	55.4	53.5	37	98.5	95.2	97	141.7	136.8	57	184.9	178.5
18	12.9	12.5	78	56.1	54.2	38	99.3	95.9	98	142.4	137.5	58	185.6	179.2
19	13.7	13.2	79	56.8	54.9	39	100.0	96.6	99	143.1	138.2	59	186.3	179.9
20	14.4	13.9	80	57.5	55.6	40	100.7	97.3	200	143.9	138.9	60	187.0	180.6
21	15.1	14.6	81	58.3	56.3	41	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	42	102.1	98.6	02	145.3	140.3	62	188.5	182.0
23	16.5	16.0	83	59.7	57.7	43	102.9	99.3	03	146.0	141.0	63	189.2	182.7
24	17.3	16.7	84	60.4	58.4	44	103.6	100.0	04	146.7	141.7	64	189.9	183.4
25	18.0	17.4	85	61.1	59.0	45	104.3	100.7	05	147.5	142.4	65	190.6	184.1
26	18.7	18.1	86	61.9	59.7	46	105.0	101.4	06	148.2	143.1	66	191.3	184.8
27	19.4	18.8	87	62.6	60.4	47	105.7	102.1	07	148.9	143.8	67	192.1	185.5
28	20.1	19.5	88	63.3	61.1	48	106.5	102.8	08	149.6	144.5	68	192.8	186.2
29	20.9	20.1	89	64.0	61.8	49	107.2	103.5	09	150.3	145.2	69	193.5	186.9
30	21.6	20.8	90	64.7	62.5	50	107.9	104.2	10	151.1	145.9	70	194.2	187.6
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.3
32	23.0	22.2	92	66.2	63.9	52	109.3	105.6	12	152.5	147.3	72	195.7	188.9
33	23.7	22.9	93	66.9	64.6	53	110.1	106.3	13	153.2	148.0	73	196.4	189.6
34	24.5	23.6	94	67.6	65.3	54	110.8	107.0	14	153.9	148.7	74	197.1	190.3
35	25.2	24.3	95	68.3	66.0	55	111.5	107.7	15	154.7	149.4	75	197.8	191.0
36	25.9	25.0	96	69.1	66.7	56	112.2	108.4	16	155.4	150.0	76	198.5	191.7
37	26.6	25.7	97	69.8	67.4	57	112.9	109.1	17	156.1	150.7	77	199.3	192.4
38	27.3	26.4	98	70.5	68.1	58	113.7	109.8	18	156.8	151.4	78	200.0	193.1
39	28.1	27.1	99	71.2	68.8	59	114.4	110.5	19	157.5	152.1	79	200.7	193.8
40	28.8	27.9	100	71.9	69.5	60	115.1	111.1	20	158.3	152.8	80	201.4	194.5
41	29.5	28.5	101	72.7	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	02	73.4	70.9	62	116.5	112.5	22	159.7	154.2	82	202.9	195.9
43	30.9	29.9	03	74.1	71.5	63	117.3	113.2	23	160.4	154.9	83	203.6	196.6
44	31.7	30.6	04	74.8	72.2	64	118.0	113.9	24	161.1	155.6	84	204.3	197.3
45	32.4	31.3	05	75.5	72.9	65	118.7	114.6	25	161.9	156.3	85	205.0	198.0
46	33.1	32.0	06	76.3	73.6	66	119.4	115.3	26	162.6	157.0	86	205.7	198.7
47	33.8	32.6	07	77.0	74.3	67	120.1	116.0	27	163.3	157.7	87	206.5	199.4
48	34.5	33.3	08	77.7	75.0	68	120.8	116.7	28	164.0	158.4	88	207.2	200.1
49	35.2	34.0	09	78.4	75.7	69	121.6	117.4	29	164.7	159.1	89	207.9	200.8
50	36.0	34.7	10	79.1	76.4	70	122.3	118.1	30	165.4	159.8	90	208.6	201.5
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.5	291	209.3	202.1
52	37.4	36.1	12	80.6	77.8	72	123.7	119.5	32	166.9	161.2	92	210.0	202.8
53	38.1	36.8	13	81.3	78.5	73	124.4	120.2	33	167.6	161.9	93	210.8	203.5
54	38.8	37.5	14	82.0	79.2	74	125.2	120.9	34	168.3	162.6	94	211.5	204.2
55	39.6	38.2	15	82.7	79.9	75	125.9	121.6	35	169.0	163.2	95	212.2	204.9
56	40.3	38.9	16	83.4	80.6	76	126.6	122.3	36	169.8	163.9	96	212.9	205.6
57	41.0	39.6	17	84.2	81.3	77	127.3	123.0	37	170.5	164.6	97	213.6	206.3
58	41.7	40.3	18	84.9	82.0	78	128.0	123.6	38	171.2	165.3	98	214.4	207.0
59	42.4	41.0	19	85.6	82.7	79	128.8	124.3	39	171.9	166.0	99	215.1	207.7
60	43.2	41.7	20	86.3	83.4	80	129.5	125.0	40	172.6	166.7	300	215.8	208.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 46 Degrees.]

TABLE II.

61

Difference of Latitude and Departure for 45 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	31	92.6	92.6	91	135.1	135.1	51	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	41	99.7	99.7	201	142.1	142.1	61	184.5	184.5
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	202	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	203	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	204	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	205	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	206	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	207	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	208	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	209	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	210	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	51	106.8	106.8	211	149.2	149.2	71	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	212	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	213	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	214	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	215	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	216	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	217	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	218	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	219	154.8	154.8	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	220	155.5	155.5	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	61	113.8	113.8	221	156.3	156.3	81	198.7	198.7
42	29.7	29.7	102	72.1	72.1	62	114.6	114.6	222	157.0	157.0	82	199.4	199.4
43	30.4	30.4	103	72.8	72.8	63	115.3	115.3	223	157.7	157.7	83	200.1	200.1
44	31.1	31.1	104	73.5	73.5	64	116.0	116.0	224	158.4	158.4	84	200.8	200.8
45	31.8	31.8	105	74.2	74.2	65	116.7	116.7	225	159.1	159.1	85	201.5	201.5
46	32.5	32.5	106	75.0	75.0	66	117.4	117.4	226	159.8	159.8	86	202.2	202.2
47	33.2	33.2	107	75.7	75.7	67	118.1	118.1	227	160.5	160.5	87	202.9	202.9
48	33.9	33.9	108	76.4	76.4	68	118.8	118.8	228	161.2	161.2	88	203.6	203.6
49	34.6	34.6	109	77.1	77.1	69	119.5	119.5	229	161.9	161.9	89	204.4	204.4
50	35.4	35.4	110	77.8	77.8	70	120.2	120.2	230	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	71	120.9	120.9	231	163.3	163.3	91	205.8	205.8
52	36.8	36.8	112	79.2	79.2	72	121.6	121.6	232	164.0	164.0	92	206.5	206.5
53	37.5	37.5	113	79.9	79.9	73	122.3	122.3	233	164.8	164.8	93	207.2	207.2
54	38.2	38.2	114	80.6	80.6	74	123.0	123.0	234	165.5	165.5	94	207.9	207.9
55	38.9	38.9	115	81.3	81.3	75	123.7	123.7	235	166.2	166.2	95	208.6	208.6
56	39.6	39.6	116	82.0	82.0	76	124.5	124.5	236	166.9	166.9	96	209.3	209.3
57	40.3	40.3	117	82.7	82.7	77	125.2	125.2	237	167.6	167.6	97	210.0	210.0
58	41.0	41.0	118	83.4	83.4	78	125.9	125.9	238	168.3	168.3	98	210.7	210.7
59	41.7	41.7	119	84.1	84.1	79	126.6	126.6	239	169.0	169.0	99	211.4	211.4
60	42.4	42.4	120	84.9	84.9	80	127.3	127.3	240	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 45 Degrees.

TABLE III.

MERIDIONAL PARTS.

M.	0d.	1d.	2d.	3d.	4d.	5d.	6d.	7d.	8d.	9d.	10d.	11d.	12d.	13d.	M.
0	0	60	120	180	240	300	361	421	482	542	603	664	725	787	0
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	1
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	2
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	3
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	4
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	5
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	6
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	7
8	8	68	128	188	248	308	369	429	490	550	611	672	733	795	8
9	9	69	129	189	249	309	370	430	491	551	612	673	734	796	9
10	10	70	130	190	250	310	371	431	492	552	613	674	735	797	10
11	11	71	131	191	251	311	372	432	493	553	614	675	736	798	11
12	12	72	132	192	252	312	373	433	494	554	615	676	737	799	12
13	13	73	133	193	253	313	374	434	495	555	616	677	738	800	13
14	14	74	134	194	254	314	375	435	496	556	617	678	739	801	14
15	15	75	135	195	255	315	376	436	497	557	618	679	740	802	15
16	16	76	136	196	256	316	377	437	498	558	619	680	741	803	16
17	17	77	137	197	257	317	378	438	499	559	620	681	742	804	17
18	18	78	138	198	258	318	379	439	500	560	621	682	743	805	18
19	19	79	139	199	259	319	380	440	501	561	622	683	744	806	19
20	20	80	140	200	260	320	381	441	502	562	623	684	745	807	20
21	21	81	141	201	261	321	382	442	503	563	624	685	746	808	21
22	22	82	142	202	262	322	383	443	504	564	625	686	747	809	22
23	23	83	143	203	263	323	384	444	505	565	626	687	748	810	23
24	24	84	144	204	264	324	385	445	506	566	627	688	749	811	24
25	25	85	145	205	265	325	386	446	507	567	628	689	750	812	25
26	26	86	146	206	266	326	387	447	508	568	629	690	751	813	26
27	27	87	147	207	267	327	388	448	509	569	630	691	752	814	27
28	28	88	148	208	268	328	389	449	510	570	631	692	753	815	28
29	29	89	149	209	269	329	390	450	511	571	632	693	754	816	29
30	30	90	150	210	270	330	391	451	512	572	633	694	755	817	30
31	31	91	151	211	271	331	392	452	513	573	634	695	756	818	31
32	32	92	152	212	272	332	393	453	514	574	635	696	757	819	32
33	33	93	153	213	273	333	394	454	515	575	636	697	758	820	33
34	34	94	154	214	274	334	395	455	516	576	637	698	759	821	34
35	35	95	155	215	275	335	396	456	517	577	638	699	760	822	35
36	36	96	156	216	276	336	397	457	518	578	639	700	761	823	36
37	37	97	157	217	277	337	398	458	519	579	640	701	762	824	37
38	38	98	158	218	278	338	399	459	520	580	641	702	763	825	38
39	39	99	159	219	279	339	400	460	521	581	642	703	764	826	39
40	40	100	160	220	280	340	401	461	522	582	643	704	765	827	40
41	41	101	161	221	281	341	402	462	523	583	644	705	766	828	41
42	42	102	162	222	282	342	403	463	524	584	645	706	767	829	42
43	43	103	163	223	283	343	404	464	525	585	646	707	768	830	43
44	44	104	164	224	284	344	405	465	526	586	647	708	769	831	44
45	45	105	165	225	285	345	406	466	527	587	648	709	770	832	45
46	46	106	166	226	286	346	407	467	528	588	649	710	771	833	46
47	47	107	167	227	287	347	408	468	529	589	650	711	772	834	47
48	48	108	168	228	288	348	409	469	530	590	651	712	773	835	48
49	49	109	169	229	289	349	410	470	531	591	652	713	774	836	49
50	50	110	170	230	290	350	411	471	532	592	653	714	775	837	50
51	51	111	171	231	291	351	412	472	533	593	654	715	776	838	51
52	52	112	172	232	292	352	413	473	534	594	655	716	777	839	52
53	53	113	173	233	293	353	414	474	535	595	656	717	778	840	53
54	54	114	174	234	294	354	415	475	536	596	657	718	779	841	54
55	55	115	175	235	295	355	416	476	537	597	658	719	780	842	55
56	56	116	176	236	296	356	417	477	538	598	659	720	781	843	56
57	57	117	177	237	297	357	418	478	539	599	660	721	782	844	57
58	58	118	178	238	298	358	419	479	540	600	661	722	783	845	58
59	59	119	179	239	299	359	420	480	541	601	662	723	784	846	59
60	60	120	180	240	300	360	421	481	542	602	663	724	785	847	60

TABLE III.

63

MERIDIONAL PARTS.

M.	14d.	15d.	16d.	17d.	18d.	19d.	20d.	21d.	22d.	23d.	24d.	25d.	26d.	27d.	M.
0	848	910	973	1035	1098	1161	1224	1289	1354	1419	1484	1550	1616	1681	0
1	850	911	974	1037	1100	1163	1226	1291	1356	1421	1486	1552	1618	1683	1
2	851	913	976	1039	1102	1165	1228	1293	1358	1423	1488	1554	1620	1685	2
3	852	914	977	1040	1103	1166	1229	1294	1359	1424	1489	1555	1621	1686	3
4	853	915	977	1041	1104	1167	1230	1295	1360	1425	1490	1556	1622	1687	4
5	854	916	978	1042	1105	1168	1231	1296	1361	1426	1491	1557	1623	1688	5
6	855	917	979	1043	1106	1169	1232	1297	1362	1427	1492	1558	1624	1689	6
7	856	918	980	1044	1107	1170	1233	1298	1363	1428	1493	1559	1625	1690	7
8	857	919	981	1045	1108	1171	1234	1299	1364	1429	1494	1560	1626	1691	8
9	858	920	982	1046	1109	1172	1235	1300	1365	1430	1495	1561	1627	1692	9
10	859	921	983	1047	1110	1173	1236	1301	1366	1431	1496	1562	1628	1693	10
11	860	922	984	1048	1111	1174	1237	1302	1367	1432	1497	1563	1629	1694	11
12	861	923	985	1049	1112	1175	1238	1303	1368	1433	1498	1564	1630	1695	12
13	862	924	986	1050	1113	1176	1239	1304	1369	1434	1499	1565	1631	1696	13
14	863	925	987	1051	1114	1177	1240	1305	1370	1435	1500	1566	1632	1697	14
15	864	926	988	1052	1115	1178	1241	1306	1371	1436	1501	1567	1633	1698	15
16	865	927	989	1053	1116	1179	1242	1307	1372	1437	1502	1568	1634	1699	16
17	866	928	990	1054	1117	1180	1243	1308	1373	1438	1503	1569	1635	1700	17
18	867	929	991	1055	1118	1181	1244	1309	1374	1439	1504	1570	1636	1701	18
19	868	930	992	1056	1119	1182	1245	1310	1375	1440	1505	1571	1637	1702	19
20	869	931	993	1057	1120	1183	1246	1311	1376	1441	1506	1572	1638	1703	20
21	870	932	994	1058	1121	1184	1247	1312	1377	1442	1507	1573	1639	1704	21
22	871	933	995	1059	1122	1185	1248	1313	1378	1443	1508	1574	1640	1705	22
23	872	934	996	1060	1123	1186	1249	1314	1379	1444	1509	1575	1641	1706	23
24	873	935	997	1061	1124	1187	1250	1315	1380	1445	1510	1576	1642	1707	24
25	874	936	998	1062	1125	1188	1251	1316	1381	1446	1511	1577	1643	1708	25
26	875	937	999	1063	1126	1189	1252	1317	1382	1447	1512	1578	1644	1709	26
27	876	938	1000	1064	1127	1190	1253	1318	1383	1448	1513	1579	1645	1710	27
28	877	939	1001	1065	1128	1191	1254	1319	1384	1449	1514	1580	1646	1711	28
29	878	940	1002	1066	1129	1192	1255	1320	1385	1450	1515	1581	1647	1712	29
30	879	941	1003	1067	1130	1193	1256	1321	1386	1451	1516	1582	1648	1713	30
31	880	942	1004	1068	1131	1194	1257	1322	1387	1452	1517	1583	1649	1714	31
32	881	943	1005	1069	1132	1195	1258	1323	1388	1453	1518	1584	1650	1715	32
33	882	944	1006	1070	1133	1196	1259	1324	1389	1454	1519	1585	1651	1716	33
34	883	945	1007	1071	1134	1197	1260	1325	1390	1455	1520	1586	1652	1717	34
35	884	946	1008	1072	1135	1198	1261	1326	1391	1456	1521	1587	1653	1718	35
36	885	947	1009	1073	1136	1199	1262	1327	1392	1457	1522	1588	1654	1719	36
37	886	948	1010	1074	1137	1200	1263	1328	1393	1458	1523	1589	1655	1720	37
38	887	949	1011	1075	1138	1201	1264	1329	1394	1459	1524	1590	1656	1721	38
39	888	950	1012	1076	1139	1202	1265	1330	1395	1460	1525	1591	1657	1722	39
40	889	951	1013	1077	1140	1203	1266	1331	1396	1461	1526	1592	1658	1723	40
41	890	952	1014	1078	1141	1204	1267	1332	1397	1462	1527	1593	1659	1724	41
42	891	953	1015	1079	1142	1205	1268	1333	1398	1463	1528	1594	1660	1725	42
43	892	954	1016	1080	1143	1206	1269	1334	1399	1464	1529	1595	1661	1726	43
44	893	955	1017	1081	1144	1207	1270	1335	1400	1465	1530	1596	1662	1727	44
45	894	956	1018	1082	1145	1208	1271	1336	1401	1466	1531	1597	1663	1728	45
46	895	957	1019	1083	1146	1209	1272	1337	1402	1467	1532	1598	1664	1729	46
47	896	958	1020	1084	1147	1210	1273	1338	1403	1468	1533	1599	1665	1730	47
48	897	959	1021	1085	1148	1211	1274	1339	1404	1469	1534	1600	1666	1731	48
49	898	960	1022	1086	1149	1212	1275	1340	1405	1470	1535	1601	1667	1732	49
50	899	961	1023	1087	1150	1213	1276	1341	1406	1471	1536	1602	1668	1733	50
51	900	962	1024	1088	1151	1214	1277	1342	1407	1472	1537	1603	1669	1734	51
52	901	963	1025	1089	1152	1215	1278	1343	1408	1473	1538	1604	1670	1735	52
53	902	964	1026	1090	1153	1216	1279	1344	1409	1474	1539	1605	1671	1736	53
54	903	965	1027	1091	1154	1217	1280	1345	1410	1475	1540	1606	1672	1737	54
55	904	966	1028	1092	1155	1218	1281	1346	1411	1476	1541	1607	1673	1738	55
56	905	967	1029	1093	1156	1219	1282	1347	1412	1477	1542	1608	1674	1739	56
57	906	968	1030	1094	1157	1220	1283	1348	1413	1478	1543	1609	1675	1740	57
58	907	969	1031	1095	1158	1221	1284	1349	1414	1479	1544	1610	1676	1741	58
59	908	970	1032	1096	1159	1222	1285	1350	1415	1480	1545	1611	1677	1742	59
60	909	971	1033	1097	1160	1223	1286	1351	1416	1481	1546	1612	1678	1743	60
61	910	972	1034	1098	1161	1224	1287	1352	1417	1482	1547	1613	1679	1744	61
62	911	973	1035	1099	1162	1225	1288	1353	1418	1483	1548	1614	1680	1745	62
63	912	974	1036	1100	1163	1226	1289	1354	1419	1484	1549	1615	1681	1746	63

TABLE III.

MERIDIONAL PARTS.

M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.
0	1751	1819	1888	1958	2028	2100	2171	2244	2318	2393	2468	2545	2623	2702	0
1	52	21	90	59	30	01	73	46	19	94	70	46	24	03	1
2	53	22	91	60	31	02	74	47	20	95	71	48	25	04	2
3	55	23	92	62	32	03	75	48	22	96	72	49	27	06	3
4	56	24	93	63	33	04	76	49	23	98	73	50	28	07	4
5	1757	1825	1894	1964	2034	2105	2178	2250	2324	2399	2475	2551	2629	2708	5
6	58	26	95	65	35	07	79	52	25	100	76	53	31	10	6
7	59	27	96	66	37	08	80	53	27	01	77	54	32	11	7
8	60	28	98	68	38	09	81	54	28	03	78	55	33	12	8
9	61	30	99	69	39	10	82	55	29	04	80	57	34	14	9
10	1762	1831	1900	1970	2040	2111	2184	2257	2330	2405	2481	2558	2636	2715	10
11	64	32	01	71	41	13	85	58	32	06	82	59	37	16	11
12	65	33	02	72	43	14	86	59	33	08	84	60	38	18	12
13	66	34	03	73	44	15	87	60	34	09	85	62	40	19	13
14	67	35	05	74	45	16	88	61	35	10	86	63	41	20	14
15	1768	1837	1906	1976	2046	2117	2190	2263	2337	2411	2487	2564	2642	2721	15
16	69	38	07	77	47	19	91	64	38	13	89	66	44	23	16
17	70	39	08	78	48	20	92	65	39	14	90	67	45	24	17
18	72	40	09	79	50	21	93	66	40	15	91	68	46	26	18
19	73	41	10	80	51	22	94	68	42	16	92	69	48	27	19
20	1774	1842	1912	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	2728	20
21	75	43	13	83	53	25	97	70	44	19	95	72	50	29	21
22	76	45	14	84	54	26	98	71	45	20	96	73	51	31	22
23	77	46	15	85	56	27	99	72	46	22	98	75	53	32	23
24	78	47	16	86	57	28	100	74	48	23	99	76	54	34	24
25	1780	1848	1917	1987	2058	2129	2202	2275	2349	2424	2500	2577	2655	2736	25
26	81	49	18	88	59	31	03	76	50	25	01	78	57	36	26
27	82	50	20	90	60	32	04	77	51	27	03	80	59	37	27
28	83	52	21	91	61	33	05	79	53	28	04	81	60	39	28
29	84	53	22	92	63	34	07	80	54	29	06	82	61	40	29
30	1785	1854	1923	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	2742	30
31	86	55	24	94	65	37	09	82	56	32	08	85	63	43	31
32	87	56	25	95	66	38	10	83	58	33	09	86	65	44	32
33	89	57	27	97	67	39	11	85	59	34	10	88	66	46	33
34	90	58	28	98	69	40	13	86	60	36	12	89	67	47	34
35	1791	1860	1929	1999	2070	2141	2214	2287	2361	2437	2513	2590	2669	2748	35
36	92	61	30	100	71	43	15	88	63	38	14	91	70	50	36
37	93	62	31	01	72	44	16	90	64	39	15	93	71	51	37
38	94	63	32	02	73	45	17	91	65	40	17	94	73	52	38
39	95	64	34	04	75	46	19	92	66	42	18	95	74	54	39
40	1797	1865	1935	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	2756	40
41	98	66	36	06	77	47	21	95	69	44	21	98	76	56	41
42	99	68	37	07	78	50	22	96	70	45	22	99	78	58	42
43	1800	69	38	08	79	51	24	97	71	47	23	100	79	59	43
44	01	70	39	10	80	52	25	98	73	48	24	02	80	60	44
45	1802	1871	1941	2011	2082	2153	2226	2299	2374	2449	2526	2603	2682	2762	45
46	03	72	42	12	83	55	27	101	75	51	27	04	83	63	46
47	05	73	43	13	84	56	28	02	76	52	28	06	84	64	47
48	06	75	44	14	85	57	30	03	78	53	30	07	86	66	48
49	07	76	45	15	86	58	31	04	79	54	31	08	87	67	49
50	1808	1877	1946	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	2768	50
51	09	78	48	18	89	61	33	07	81	57	33	11	90	70	51
52	10	79	49	19	90	62	35	08	83	58	35	12	91	71	52
53	11	80	50	20	91	63	36	09	84	59	36	14	92	72	53
54	13	81	51	21	92	64	37	11	85	61	37	15	94	74	54
55	1814	1883	1952	2022	2094	2165	2238	2312	2386	2462	2538	2616	2695	2775	55
56	15	84	53	24	95	67	39	13	88	63	40	17	96	76	56
57	16	85	55	25	96	68	41	14	89	64	41	19	98	78	57
58	17	86	56	26	97	69	42	16	90	66	42	20	99	79	58
59	18	87	57	27	98	70	43	17	91	67	44	21	100	80	59
M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.

TABLE III.

65

MERIDIONAL PARTS.

M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.
0	2782	2863	2946	3030	3116	3203	3292	3382	3474	3569	3665	3764	3865	3968	0
1	83	64	47	31	17	04	93	84	76	70	67	65	66	70	1
2	86	66	49	33	18	06	95	85	78	72	68	67	69	71	2
3	87	67	50	34	20	07	96	87	79	74	70	69	70	72	3
4	87	69	51	36	21	09	98	89	81	75	72	70	71	73	4
5	2788	2870	2953	3037	3123	3210	3299	3390	3482	3577	3673	3772	3873	3977	5
6	90	71	54	38	24	12	3301	91	84	78	75	74	75	78	6
7	91	73	56	40	26	13	02	93	85	80	77	75	77	80	7
8	92	74	57	41	27	14	03	94	87	82	78	77	78	82	8
9	94	75	58	43	29	16	05	96	89	83	80	79	80	84	9
10	2795	2877	2960	3044	3130	3217	3306	3397	3489	3585	3681	3780	3882	3985	10
11	97	78	61	46	31	19	08	99	92	86	83	82	83	87	11
12	98	80	63	47	33	20	09	3400	93	88	85	84	85	89	12
13	99	81	64	48	34	22	11	02	95	90	86	85	87	91	13
14	2801	82	65	50	36	23	12	03	96	91	88	87	89	92	14
15	2807	2884	2967	3051	3137	3225	3314	3405	3498	3593	3690	3789	3890	3994	15
16	03	85	68	53	39	26	16	07	99	94	91	90	92	96	16
17	05	86	70	54	40	28	17	08	3501	96	93	92	94	98	17
18	06	88	71	55	42	29	19	10	03	98	95	94	95	99	18
19	07	89	73	57	43	31	20	11	04	99	96	95	97	1001	19
20	2809	2891	2974	3058	3144	3232	3322	3413	3506	3601	3698	3797	3899	4003	20
21	10	92	75	60	46	34	23	14	07	02	99	99	3901	03	21
22	11	93	76	61	47	35	25	16	09	04	3701	3800	02	06	22
23	13	95	78	63	49	37	26	17	10	06	03	02	04	08	23
24	14	96	79	64	50	38	28	19	12	07	04	04	06	10	24
25	2815	2897	2981	3065	3152	3240	3329	3420	3514	3609	3706	3806	3907	4012	25
26	17	99	82	67	53	41	31	22	15	10	08	07	09	11	26
27	18	2900	83	68	55	42	32	23	17	12	09	09	11	13	27
28	20	02	85	70	56	44	33	25	18	14	11	11	13	15	28
29	21	03	86	71	57	45	35	27	20	16	13	12	14	17	29
30	2822	2904	2988	3073	3159	3247	3337	3428	3521	3617	3714	3814	3915	4021	30
31	24	06	89	74	60	48	38	30	23	18	16	16	18	20	31
32	25	07	91	75	62	50	40	31	25	20	17	17	19	21	32
33	26	08	92	77	63	51	41	33	26	22	19	19	21	22	33
34	28	10	93	78	65	53	43	34	28	24	21	21	22	23	34
35	2829	2911	2995	3080	3166	3254	3344	3436	3529	3625	3722	3821	3921	4028	35
36	30	13	96	81	68	56	46	37	31	26	24	24	26	27	36
37	31	14	98	83	69	57	47	39	32	28	26	26	28	29	37
38	33	16	99	84	71	59	49	40	34	30	27	27	29	30	38
39	34	17	3000	85	72	60	50	42	36	31	29	29	31	31	39
40	2836	2918	3002	3087	3173	3262	3352	3443	3537	3633	3731	3831	3932	4040	40
41	37	19	03	88	75	63	53	45	39	34	32	32	34	35	41
42	39	21	05	90	76	65	55	47	40	36	34	34	36	37	42
43	40	22	06	91	78	66	56	48	42	38	36	36	38	39	43
44	41	24	07	93	79	68	58	50	43	39	37	37	40	41	44
45	2843	2925	3009	3094	3181	3269	3359	3451	3545	3641	3739	3839	3940	4050	45
46	44	26	10	95	82	71	61	53	47	43	41	41	43	44	46
47	45	28	12	97	84	72	62	54	48	44	42	43	45	46	47
48	47	29	13	98	85	74	64	56	50	46	44	44	46	47	48
49	48	31	14	3100	87	76	65	57	51	47	46	46	48	49	49
50	2849	2932	3016	3101	3188	3277	3367	3459	3553	3649	3747	3848	3950	4060	50
51	51	33	17	03	90	78	68	60	55	51	49	49	52	53	51
52	52	35	19	04	91	80	70	62	56	52	50	51	54	55	52
53	54	36	20	05	92	81	71	64	58	54	52	53	56	57	53
54	55	37	21	07	94	83	73	66	60	56	54	55	58	59	54
55	2856	2939	3023	3108	3195	3284	3374	3467	3561	3657	3755	3856	3959	4070	55
56	58	39	24	10	97	86	76	68	62	59	57	58	61	62	56
57	59	42	26	11	98	87	78	70	64	60	59	60	63	64	57
58	60	43	27	13	3200	89	79	71	66	62	60	61	64	65	58
59	62	44	29	14	91	90	81	73	67	64	62	63	66	67	59
M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.

TABLE III.

MERIDIONAL PARTS.

M	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M
0	4074	4183	4294	4409	4527	4649	4775	4905	5039	5179	5324	5474	5631	5796	0
1	76	84	96	11	29	51	77	07	42	81	26	77	33	97	1
2	77	86	98	13	31	53	79	09	44	84	28	79	36	5800	2
3	79	88	4300	15	35	55	81	12	46	86	31	82	39	03	3
4	81	90	02	17	35	57	84	14	49	88	33	84	42	06	4
5	4083	4192	4304	4419	4537	4660	4786	4916	5051	5191	5336	5487	5644	5809	5
6	85	94	06	21	39	62	88	18	53	91	38	89	47	11	6
7	86	95	08	23	41	64	90	20	55	95	41	92	50	14	7
8	88	97	09	25	43	66	92	23	58	98	43	95	52	17	8
9	90	99	11	27	45	68	94	25	60	5200	46	97	55	20	9
10	4092	4201	4313	4429	4547	4670	4796	4927	5062	5203	5348	5500	5658	5823	10
11	94	03	15	31	49	72	98	29	65	101	51	02	60	25	11
12	95	05	17	33	51	74	4801	51	67	07	53	05	63	28	12
13	97	07	19	34	53	76	03	34	69	10	54	07	66	31	13
14	99	08	21	36	55	78	05	36	71	12	56	10	68	34	14
15	4101	4210	4323	4438	4557	4680	4807	4938	5074	5214	5361	5513	5671	5837	15
16	03	12	25	40	59	82	09	40	76	17	63	15	74	39	16
17	04	14	27	42	62	84	11	42	78	19	66	18	76	42	17
18	06	16	28	44	64	87	14	45	81	22	68	20	79	45	18
19	08	18	30	46	66	89	16	47	83	24	71	23	82	48	19
20	4110	4220	4332	4448	4568	4691	4818	4949	5085	5226	5373	5526	5685	5851	20
21	12	21	34	50	70	93	20	51	88	29	76	28	87	54	21
22	13	23	36	52	72	95	22	54	90	31	78	31	90	56	22
23	15	25	38	54	74	97	24	56	92	34	80	33	93	59	23
24	17	27	40	56	76	99	26	58	95	36	83	35	95	62	24
25	4119	4229	4342	4458	4578	4701	4829	4960	5097	5238	5385	5539	5698	5865	25
26	21	31	44	60	80	03	31	63	99	41	88	41	5701	68	26
27	22	32	46	62	82	05	33	65	5102	43	90	44	04	71	27
28	24	34	47	64	84	07	35	67	04	44	93	46	06	74	28
29	26	36	49	66	86	10	37	69	06	46	95	49	09	76	29
30	4128	4238	4351	4466	4588	4712	4839	4972	5108	5250	5398	5552	5712	5879	30
31	30	40	53	70	90	14	42	74	11	53	5401	54	15	82	31
32	32	42	55	72	92	16	44	76	13	55	03	57	17	85	32
33	33	44	57	74	94	18	46	78	15	56	06	59	20	88	33
34	35	4	59	76	96	20	48	81	18	60	08	62	23	91	34
35	4137	4247	4361	4478	4598	4722	4850	4983	5120	5263	5411	5565	5725	5894	35
36	39	49	63	80	4600	24	52	85	22	65	13	67	25	96	36
37	41	51	65	82	02	26	55	87	25	67	16	70	31	99	37
38	42	53	67	84	04	28	57	90	27	70	18	73	34	5902	38
39	44	55	69	86	06	31	59	92	29	72	21	75	36	99	39
40	4146	4257	4370	4488	4608	4733	4861	4994	5132	5275	5423	5578	5739	5908	40
41	48	59	72	90	10	35	63	96	34	77	26	80	38	11	41
42	50	60	74	92	12	37	65	99	36	80	28	83	40	14	42
43	52	62	76	94	14	39	68	5001	39	82	31	86	47	17	43
44	53	64	78	95	16	41	70	03	41	84	33	88	50	19	44
45	4155	4266	4380	4497	4618	4743	4872	5005	5143	5287	5436	5591	5753	5922	45
46	57	68	82	99	19	45	74	08	47	89	38	94	56	25	46
47	59	70	84	4601	23	47	76	10	49	92	41	96	58	28	47
48	61	72	86	03	25	50	79	12	51	94	43	99	61	31	48
49	62	74	88	05	27	52	81	14	53	97	45	5602	64	34	49
50	4164	4275	4390	4507	4629	4754	4883	5017	5155	5299	5448	5604	5767	5937	50
51	66	77	92	09	31	56	85	19	55	5301	51	07	70	40	51
52	68	79	94	11	33	58	87	21	60	04	54	10	72	43	52
53	70	81	96	13	35	60	90	23	62	06	56	12	75	46	53
54	72	83	98	15	37	62	92	26	64	09	59	15	78	48	54
55	4173	4285	4399	4517	4639	4764	4894	5028	5167	5311	5461	5617	5781	5951	55
56	75	87	4401	19	41	66	96	30	69	14	64	20	83	54	56
57	77	89	03	21	43	69	98	33	72	16	66	23	86	57	57
58	79	91	05	23	45	71	4901	35	74	19	69	25	89	60	58
59	81	92	07	25	47	73	03	37	76	21	71	27	92	63	59
M.	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M.

TABLE III.

67

MERIDIONAL PARTS.

M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	N.
0	5966	6146	6335	6534	6746	6970	7210	7467	7746	8046	8373	8739	9146	9606	0
1	69	49	38	38	49	74	14	72	49	51	51	45	53	14	1
2	72	52	41	41	53	78	18	76	54	56	57	52	60	22	2
3	75	55	45	45	57	82	22	80	59	61	63	58	67	31	3
4	78	58	48	48	60	86	27	85	64	67	69	62	74	39	4
5	5981	6161	6351	6552	6764	6990	7231	7490	7769	8072	8404	8771	9182	9647	5
6	84	64	54	55	68	94	35	94	74	77	10	78	89	55	6
7	86	67	58	58	71	97	39	98	78	83	16	84	96	64	7
8	89	70	61	62	75	100	43	100	83	88	22	91	102	72	8
9	92	73	64	65	79	05	47	07	86	91	27	97	11	80	9
10	5995	6177	6367	6569	6782	7009	7252	7512	7793	8099	8433	8804	9218	9689	10
11	98	80	71	72	86	13	56	16	98	104	39	10	25	97	11
12	6001	83	74	76	90	17	60	21	100	09	45	17	33	106	12
13	04	86	77	79	93	21	64	25	08	15	51	23	40	14	13
14	07	89	80	82	97	25	68	30	13	20	57	30	47	23	14
15	6010	6192	6384	6586	6801	7029	7273	7535	7817	8128	8463	8836	9256	9731	15
16	13	95	87	90	04	33	77	39	22	31	69	43	62	40	16
17	16	98	90	93	08	37	81	44	27	36	74	49	70	48	17
18	19	6201	94	97	12	41	85	48	32	41	80	56	77	57	18
19	22	05	97	6600	15	45	89	53	37	47	86	63	85	65	19
20	6025	6208	6400	6603	6819	7048	7294	7557	7842	8152	8492	8869	9292	9774	20
21	28	11	03	07	22	52	98	62	47	58	98	76	100	83	21
22	31	14	07	12	26	56	102	66	52	63	104	83	07	91	22
23	34	17	10	14	30	60	106	71	57	68	108	87	13	99	23
24	37	20	13	17	34	64	111	76	62	74	116	90	22	09	24
25	6040	6223	6417	6621	6838	7068	7315	7580	7867	8179	8522	8903	9330	9817	25
26	43	26	20	24	41	72	19	86	72	85	28	09	37	26	26
27	46	30	23	28	45	76	23	89	77	90	34	16	45	35	27
28	49	33	27	31	49	80	28	94	82	96	40	23	53	44	28
29	52	36	30	35	53	84	32	99	87	101	46	30	60	52	29
30	6055	6239	6433	6639	6856	7088	7336	7603	7892	8207	8552	8936	9368	9861	30
31	58	42	37	42	60	92	41	08	97	12	58	43	76	70	31
32	61	45	40	46	64	96	45	12	100	13	65	50	83	79	32
33	64	49	43	49	68	100	49	17	07	23	71	57	91	88	33
34	67	52	47	53	71	04	53	22	12	29	77	63	99	97	34
35	6070	6255	6450	6656	6875	7108	7358	7626	7917	8234	8583	8970	9407	9906	35
36	73	58	53	60	79	12	62	31	22	40	89	77	14	15	36
37	76	61	57	63	83	16	66	36	27	45	95	84	22	24	37
38	79	64	60	67	86	20	71	40	32	51	100	91	30	33	38
39	82	67	63	70	90	24	75	45	37	56	07	98	38	42	39
40	6085	6271	6467	6674	6894	7128	7379	7650	7942	8262	8614	8995	9415	9951	40
41	88	74	70	77	98	32	84	54	48	67	20	12	53	60	41
42	91	77	73	81	100	36	88	59	53	73	26	18	61	69	42
43	94	80	77	85	05	40	92	64	58	79	32	25	69	78	43
44	97	83	80	88	09	45	97	68	63	84	38	32	77	87	44
45	6100	6287	6483	6692	6913	7149	7401	7673	7968	8290	8644	9039	9485	9996	45
46	03	90	87	95	17	53	06	78	73	95	51	46	100	100	46
47	06	93	90	99	20	57	10	83	78	100	57	53	100	100	47
48	09	96	94	102	24	61	14	87	83	07	63	60	09	100	48
49	12	99	97	06	28	65	19	92	89	12	69	67	17	100	49
50	6115	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	9074	9525	10043	50
51	18	06	04	13	36	73	27	102	99	24	82	81	33	100	51
52	21	09	07	17	40	77	32	06	100	29	88	88	41	100	52
53	24	12	11	20	43	81	36	11	09	38	95	96	49	100	53
54	27	15	14	24	47	85	41	16	14	41	100	100	57	100	54
55	6130	6319	6517	6728	6951	7189	7445	7721	8020	8347	8707	9110	9565	10089	55
56	30	22	21	31	55	94	49	25	25	53	14	17	73	100	56
57	33	25	24	35	59	98	54	30	30	58	20	24	81	101	57
58	36	28	28	38	63	102	58	35	35	64	26	31	89	101	58
59	39	31	31	42	66	06	63	40	40	69	33	38	98	101	59
M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	N.

TABLE IV. THE SUN'S DECLINATION

FOR THE TEAM 1944.

WHICH WILL ANSWER NEARLY FOR THE YEARS 1890, 1895, 1899, 1904.

DAY.	Jan.			Feb.			March.			April.			May.			June.			July.			Aug.			Sept.			Oct.			Nov.			Dec.			Total.
	North.			South.			North.			South.			North.			South.			North.			South.			North.			South.			North.			South.			
	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.	O.	P.	F.				
1	23.5	17.18	7.89	4.38	15.9	22.6	23.7	13.0	8.14	3.16	14.31	21.52	1																								
2	23.00	17.17	7.6	5.1	15.27	22.14	23.3	17.45	7.52	3.39	14.50	22.1	2																								
3	22.55	16.44	6.43	5.24	15.45	22.21	22.55	17.29	7.30	4.3	15.9	22.10	3																								
4	22.49	16.36	6.21	5.47	16.2	22.29	22.53	17.13	7.8	4.26	15.28	22.15	4																								
5	22.43	16.8	5.57	6.10	16.19	22.35	22.48	16.57	6.43	4.49	15.46	22.26	5																								
6	22.36	15.50	5.34	6.33	16.36	22.41	22.42	16.41	6.23	5.12	16.4	22.32	6																								
7	22.29	15.32	5.10	6.55	16.53	22.47	22.36	16.24	6.1	5.35	16.32	22.40	7																								
8	22.21	15.13	4.47	7.18	17.9	22.53	22.29	16.7	5.38	5.58	16.40	22.46	8																								
9	22.13	14.54	4.23	7.40	17.25	22.58	22.22	15.56	5.15	6.21	16.57	22.52	9																								
10	22.5	14.35	4.00	8.2	17.41	23.3	22.14	15.32	4.53	6.44	17.14	23.0	10																								
11	21.56	14.15	3.36	8.24	17.56	23.7	22.7	15.15	4.30	7.6	17.31	23.3	11																								
12	21.46	13.56	3.13	8.46	18.12	23.11	21.58	14.57	4.7	7.29	17.47	23.7	12																								
13	21.37	13.36	2.49	9.5	18.27	23.14	21.50	14.34	3.44	7.52	18.3	23.11	13																								
14	21.26	13.16	2.26	9.30	18.41	23.16	21.41	14.20	3.21	9.14	18.19	23.15	14																								
15	21.16	12.55	2.2	9.51	18.55	23.20	21.32	14.1	2.58	8.36	18.34	23.18	15																								
16	21.5	12.35	1.35	10.12	19.9	23.23	21.22	13.42	2.35	9.58	18.49	23.21	16																								
17	20.54	12.14	1.15	10.33	19.23	23.24	21.12	13.23	2.11	9.21	19.4	23.23	17																								
18	20.42	11.53	0.51	10.54	19.36	23.26	21.1	13.4	1.49	9.42	19.18	23.25	18																								
19	20.30	11.32	0.27	11.15	19.49	23.27	20.51	12.44	1.25	10.4	19.35	23.26	19																								
20	20.17	11.11	0.48	11.36	20.2	23.28	20.39	12.25	1.1	10.26	19.46	23.27	20																								
21	20.4	10.49	0.20	11.56	20.14	23.28	20.28	12.5	0.39	10.47	20.00	23.28	21																								
22	19.51	10.27	0.44	12.16	20.26	23.29	20.16	11.44	0.15	11.9	20.13	23.29	22																								
23	19.37	10.6	1.8	12.36	20.38	23.27	20.4	11.24	0.98	11.30	20.26	23.27	23																								
24	19.23	9.44	1.31	12.56	20.49	23.26	19.52	11.4	0.32	11.51	20.37	23.26	24																								
25	19.9	9.21	1.55	13.16	21.00	23.25	19.39	10.43	0.56	12.12	20.49	23.25	25																								
26	18.54	8.59	2.18	13.35	21.10	23.23	19.26	10.22	1.19	12.32	21.1	23.23	26																								
27	18.39	8.37	2.42	13.54	21.20	23.20	19.12	10.1	1.43	12.53	21.12	23.20	27																								
28	18.23	8.14	3.5	14.13	21.30	23.18	18.58	9.40	2.6	13.13	21.23	23.17	28																								
29	18.8	7.52	3.29	14.32	21.40	23.15	18.44	9.19	2.29	13.33	21.33	23.14	29																								
30	17.51		3.52	14.51	21.49	23.11	18.30	8.57	2.53	13.52	21.43	23.10	30																								
31	17.35		1.15		21.57		18.15	8.35		14.12		23.6	31																								

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1924.

WHICH WILL ANSWER NEARLY FOR THE YEARS 1828, 1832, 1836

WIND VELOCITY TABLE FOR THE YEARS 1922, 1923, 1924, 1925													
	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
DATE.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	Add to sp. tem.	DATE.
	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	
1	5.33	13.52	12.36	8.89	3.55	2.33	3.25	5.58	8.12	10.23	16.18	12.37	1
2	4	14.1	12.24	3.37	3.12	2.34	3.37	5.34	8.31	10.43	16.16	12.14	2
3	4.32	14.0	12.11	3.19	3.19	2.14	3.44	5.30	8.51	11.07	16.16	9.53	3
4	4.0	14.14	11.48	3.1	3.25	2.5	3.39	5.45	1.10	11.19	16.15	9.30	4
5	3.27	14.20	11.44	3.44	3.3	1.34	4.9	5.39	1.30	11.35	16.14	9.2	5
6	3.54	14.25	11.39	2.36	3.39	1.41	4.19	5.39	1.30	11.54	16.11	8.39	6
7	4.31	14.39	11.15	2.9	3.41	0.33	4.29	5.39	2.19	12.11	16.9	7.19	7
8	4.47	14.32	11.00	1.51	3.45	1.23	4.19	5.15	2.30	12.29	16.4	7.44	8
9	7.15	14.34	10.45	1.34	3.43	1.13	4.48	5.19	3.61	12.44	15.99	7.17	9
10	7.38	14.36	10.29	1.18	3.51	0.89	4.58	5.2	3.12	13.00	16.39	6.80	10
11	8.2	14.36	10.13	1.1	3.56	0.47	5.4	4.39	3.35	13.15	15.49	6.32	11
12	8.39	14.39	9.57	0.48	3.55	0.35	5.12	4.4	3.46	13.30	15.39	5.34	12
13	8.49	14.55	9.40	0.31	3.56	0.25	5.19	4.32	4.19	13.44	15.39	5.34	13
14	9.11	14.34	9.23	0.14	3.57	0.10	5.39	4.23	4.56	13.54	15.27	4.37	14
15	9.39	14.31	9.07	0.2	3.57	0.02	5.32	4.10	4.56	14.11	15.19	4.39	15
16	9.56	14.28	8.48	0.16	3.56	0.15	5.39	3.39	4.17	14.24	14.39	3.56	16
17	10.15	14.24	8.30	0.31	3.56	0.39	5.44	3.46	5.39	14.39	14.47	3.23	17
18	10.34	14.20	8.13	0.45	3.54	0.40	5.49	3.37	5.59	14.47	14.35	2.49	18
19	10.54	14.15	7.56	0.59	3.51	0.5	5.55	3.30	6.39	14.59	14.21	2.25	19
20	11.12	14.9	7.39	1.12	3.49	1.0	5.57	3.0	6.41	15.1	14.0	1.49	20
21	11.34	14.2	7.19	1.25	3.45	1.19	6.00	2.52	7.9	15.19	13.51	1.39	21
22	11.49	13.65	7.09	1.57	3.41	1.32	6.5	2.37	7.23	15.39	13.35	0.39	22
23	12.34	13.47	6.41	1.49	3.36	1.45	6.5	2.23	7.44	15.55	13.18	0.39	23
24	12.18	13.39	6.23	2.00	3.31	1.59	6.7	2.0	8.4	15.62	13.1	0.00	24
25	12.39	13.3	6.0	2.11	3.29	2.11	6.8	1.50	8.34	15.49	12.42	0.32	25
26	12.46	13.20	5										
27	12.69	13.10	4.37	2.31	3.20	2.34	6.8	1.34	8.48	15.65	12.39	0.23	26
28	13.12	13.00	4.9	2.39	3.13	2.37	6.8	1.17	8.8	15.90	12.2	1.23	27
29	13.23	12.41	4.39	2.49	3.0	2.49	6.7	1.09	9.34	16.5	11.43	2.139	28
30	13.34		4.39	2.49	2.99	2.1	6.6	0.99	9.49	16.9	11.25	2.09	29
31	13.44		4.18		2.92		6.4	0.84	10.9	16.13	11.09	2.09	30

TABLE IV. THE SUN'S DECLINATION

89

FOR THE YEAR 1823.

WHICH WILL ANSWER NEARLY FOR THE YEARS 1829, 1833, 1837.

MONTHLY MEAN THERMAL RECORD FOR THE YEARS 1884, 1885, 1886.													
DAY.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	No. of Days.
	North.	South.	South.	North.	North.	North.	North.	North.	North.	South.	South.	South.	
1	17. 57.34			4.33 13. 4.22	4.23. 2	12. 4.19				3.10 14. 27	31.50		1
2	17. 56.48			4.56 13. 22	22. 12. 23.	4.17 48	7.57			3.34 14. 46	31.49		2
3	17. 55.16			5.19 13. 40	22. 19. 23.00	17.33	7.35			3.57 15. 52	31. 8		3
4	17. 53.46			5.42 13. 58	22. 26. 22.55	17.17	7.13			4.20 15. 23	31.16		4
5	17. 52.15			6. 4 16. 15	22. 33. 22.49	17. 16.51				4.43 15. 42	31.24		5
6	17. 50.45			6.27 16. 32	22. 40. 22.43	16.45	6.29			5. 7 16. 00	31.31		6
7	17. 49.15			6.50 16. 49	22. 46. 22.37	16.25	6. 6			5.30 16. 18	31.39		7
8	17. 47.45			7.12 17. 5	22. 53. 22.31	16.11	5.44			5.53 16. 35	31.45		8
9	17. 46.15			7.35 17. 21	22. 59. 22.24	15.54	5.21			6.15 16. 53	31.51		9
10	17. 44.45			7.57 17. 37	23. 5. 22.16	15.37	4.56			6.37 17. 10	31.56		10
11	17. 43.15			8.19 17. 53	23. 12. 22. 9	15.19	4.33			7. 1 17. 27	32. 1		11
12	17. 41.45			8.41 18. 8	23. 18. 22.00	15. 1	4.12			7.24 17. 43	32. 6		12
13	17. 40.15			9. 3 18. 24	23. 25. 21.52	14.43	3.49			7.46 17. 59	32.10		13
14	17. 38.45			9.24 18. 37	23. 31. 21.43	14.24	3.26			8. 9 18. 15	32.14		14
15	17. 37.15			9.46 18. 52	23. 38. 21.34	14. 6	3. 5			8.31 18. 31	32.18		15
16	17. 35.45			10. 7 19. 6	23. 45. 21.24	13.47	2.40			8.53 18. 46	32.20		16
17	17. 34.15			10.28 19. 20	23. 52. 21.14	13.28	2.17			9.15 19. 1	32.23		17
18	17. 32.45			10.49 19. 33	23. 58. 21. 4	13. 8	1.54			9.37 19. 15	32.25		18
19	17. 31.15			11.10 19. 46	24. 5. 20.53	12.49	1.30			9.59 19. 29	32.26		19
20	17. 29.45			11.31 19. 59	24. 12. 20.42	12.29	1. 7			10.21 19. 43	32.27		20
21	17. 28.15			11.51 20. 11	24. 18. 20.31	12. 9	0.44			10.42 19. 56	32.28		21
22	17. 26.45			12.12 20. 23	24. 25. 20.19	11.49	0.30			11. 4 20. 10	32.29		22
23	17. 25.15			12.32 20. 35	24. 32. 20. 7	11.29	0.38			11.25 20. 22	32.27		23
24	17. 23.45			12.52 20. 46	24. 38. 19.55	11. 9	0.27			11.46 20. 35	32.25		24
25	17. 22.15			13.11 20. 57	24. 45. 19.42	10.48	0.50			12. 7 20. 46	32.23		25
26	17. 20.45			13.31 21. 8	24. 52. 19.29	10.27	1.13			12.27 20. 58	32.23		26
27	17. 19.15			13.50 21. 18	24. 59. 19.15	10. 6	1.37			12.46 21. 9	32.21		27
28	17. 17.45			14. 9 21. 28	25. 6. 19. 2	9.45	2.00			13. 8 21. 20	32.18		28
29	17. 16.15			14.28 21. 37	25. 13. 18.49	9.24	2.24			13.26 21. 30	32.15		29
30	17. 14.45			14.46 21. 46	25. 19. 18.33	9. 2	2.47			13.43 21. 40	32.11		30
31	17. 13.15			15. 4 21.55	25. 26. 18.19	8.41				14. 7 21. 50	32. 7		31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1823.

WHICH WILL ANSWER NEARLY FOR THE YEARS 1829, 1833, 1837.

Day	Jan. Add to app. time	Feb. Add to app. time	March Add to app. time	April Add to app. time	May Sub. fr. app. time	June Sub. fr. app. time	July Sub. fr. app. time	Aug. Add to app. time	Sept. Add to app. time	Oct. Add to app. time	Nov. Add to app. time	Dec. Add to app. time	Day
1	3.37	13.30	12.09	3.00	2. 4	2.37	3.23	3.36	0. 9	10.19	16.15	10.42	1
2	4.24	11. 4	12.27	3.41	2.12	2.29	3.52	3.34	0.29	10.37	16.16	10.20	2
3	4.44	14.17	12.14	3.23	2.19	2.17	3.45	3.36	0.47	10.56	16.16	9.59	3
4	4.20	16.15	12. 1	2. 5	2.30	2. 9	3.44	3.45	1. 6	11.16	16.15	9.38	4
5	4.47	14.25	11.47	2.47	2.31	1.39	3. 8	3.36	1.39	11.32	16.14	9. 7	5
6	4.13	14.27	11.34	2.2	2.34	1.47	4.16	3.38	1.6	11.48	16.11	8.46	6
7	4.39	14.20	11.19	2.12	2.41	1.37	4.39	3.39	2. 6	12. 7	16. 8	8.25	7
8	7. 8	14.3	11. 5	1.56	2.45	1.29	4.16	3.18	2.29	12.25	16. 4	7.45	8
9	7.36	14.34	10.44	1.37	2.49	1.15	4.44	3.11	2.6	12.38	15.38	7.22	9
10	7.46	14.35	10.32	1.21	2.50	1. 8	4.39	3. 8	3. 7	12.56	15.35	6.59	10
11	8.17	14.35	10.16	1. 8	2.54	0.10	4. 5	4.44	3.27	12.11	15.46	6.37	11
12	8.43	14.35	10. 6	0.47	2.56	0.39	4. 2	4.43	3.40	12.23	15.39	6.20	12
13	9. 5	14.36	9.48	0.2	2.57	0.27	4.17	4.39	4. 8	12.40	15.30	6.03	13
14	9.27	14.37	9.26	0.17	2.54	0.14	4.24	4.36	4.29	12.50	15.21	5. 7	14
15	9.46	14.38	9.19	0. 5	2.54	0. 2	4.30	4.13	4.40	14. 7	15.11	4.50	15
16	10. 4	14.35	9.07	0.12	2.57	0.11	4.37	4. 1	5.11	14.19	15. 8	4.30	16
17	10.29	14.27	8.56	0.27	2.58	0.24	4.42	3.49	5.23	14.31	14.48	3.54	17
18	10.49	14.16	8.47	0.41	2.54	0.37	4.43	3.37	5.38	14.45	14.39	3.40	18
19	11. 7	14.16	7.40	0.56	2.52	0.50	4.38	3.26	5.14	14.54	14.30	3.26	19
20	11.35	14. 4	7.41	1. 8	2.48	1. 3	4.30	3.10	5.25	15. 6	14. 8	3.43	20
21	11.46	13.57	7.38	1.21	2.41	1.16	4.39	2.56	5.36	15.14	13.54	3.24	21
22	11.59	13.50	7. 8	1.38	2.44	1.30	4. 4	2.41	5.17	15.23	13.50	3. 7	22
23	12.1	13.41	6.48	1.48	2.37	1.42	4. 6	2.26	5.4	15.31	13.31	2.52	23
24	12.26	13.32	6.39	1.57	2.34	1.55	4. 8	2.10	5.36	15.39	13. 6	2.34	24
25	12.44	13.25	6. 9	2. 4	2.27	2. 8	4. 7	1.54	5.19	15.46	12.44	2.16	25
26	12.57	13.13	6.11	2.18	2.21	2.39	4. 5	1.39	5.40	15.52	12.37	1.59	26
27	13. 8	13. 5	6.22	2.30	2.15	2.50	4. 7	1.23	5. 8	15.58	12. 8	1.39	27
28	13.21	12.51	6.14	2.38	2. 1	2.45	4. 7	1. 6	5.28	16. 5	11.48	1.20	28
29	13.31		6.06	2.47	2. 1	2.37	4. 8	0.40	5.40	16. 7	11.37	1.03	29
30	13.41		5.58	2.56	2. 0	2. 5	4. 8	0.24	5.40	16.11	11. 8	0.46	30
31	13.50		5.49	2.65			4. 8			16.15		0.30	31

TABLE IV. THE SUN'S DECLINATION

FOR THE YEAR 1826,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1830, 1834, 1838

DATE	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days
	South. ° ' "	South. ° ' "	South. ° ' "	North. ° ' "	North. ° ' "	North. ° ' "	North. ° ' "	North. ° ' "	North. ° ' "	North. ° ' "	South. ° ' "	South. ° ' "	
1	23 2	17 10	7.40	4.27	15.00	22. 2	23. 9	18. 7	8.24	3. 5	14.22	21.47	1
2	22.57	16 52	7.17	4.50	15.18	22.10	23. 5	17.52	8. 3	3.29	14.41	21.57	2
3	22.51	16 35	6.54	5.13	15.36	22.17	23. 1	17.37	7.41	3.51	15.00	22. 5	3
4	22.45	16.17	6.31	5.36	15.53	22.25	22.56	17.21	7.19	4.15	15.19	22.14	4
5	22.39	15.59	6. 8	5.59	16.11	22.32	22.50	17. 5	6.56	4.38	15.37	22.22	5
6	22.32	15.41	6.45	6.22	16.29	22.38	22.45	16.49	6.34	5. 1	15.56	22.29	6
7	22.25	15.23	6.22	6.44	16.44	22.44	22.39	16.32	6.12	5.24	16.13	22.36	7
8	22.17	15. 3	4.58	7. 7	17. 1	22.50	22.32	16.15	5.49	5.47	16.31	22.43	8
9	22. 9	14.44	4.35	7.29	17.17	22.55	22.25	15.58	5.26	6.10	16.49	22.49	9
10	22.00	14.25	4.11	7.51	17.33	23.00	22.18	15.41	5. 4	6.33	17. 6	22.55	10
11	21.51	14. 5	3.48	8.13	17.49	23. 5	22.10	15.23	4.41	6.56	17.22	23.00	11
12	21.41	13.45	3.24	8.35	18. 4	23. 9	22. 2	15. 5	4.19	7.18	17.39	23. 5	12
13	21.31	13.25	3. 1	8.57	18.19	23.13	21.54	14.47	3.55	7.41	17.55	23. 9	13
14	21.21	13. 5	2.37	9.19	18.34	23.16	21.45	14.29	3.32	8. 3	18.11	23.13	14
15	21.10	12.45	2.13	9.41	18.48	23.19	21.36	14.10	3. 9	8.26	18.27	23.17	15
16	20.59	12.24	1.50	10. 2	19. 2	23.21	21.27	13.51	2.46	8.48	18.42	23.20	16
17	20.47	12. 3	1.26	10.23	19.16	23.23	21.17	13.32	2.23	9.10	18.57	23.22	17
18	20.35	11.42	1. 2	10.44	19.30	23.25	21. 6	13.13	1.59	9.32	19.11	23.24	18
19	20.23	11.21	0.39	11. 5	19.43	23.26	20.56	12.54	1.36	9.54	19.26	23.26	19
20	20.10	10.59	0.15	11.26	19.56	23.27	20.45	12.34	1.13	10.15	19.40	23.27	20
21	19.57	10.38	0. 9	11.46	20. 8	23.28	20.34	12.14	0.49	10.37	19.53	23.27	21
22	19.44	10.16	0.32	12. 7	20.20	23.29	20.22	11.54	0.26	10.58	20. 6	23.28	22
23	19.30	9.54	0.56	12.27	20.32	23.27	20.10	11.34	0.32	11.19	20.19	23.27	23
24	19.16	9.32	1.20	12.47	20.43	23.26	19.58	11.14	0.21	11.40	20.31	23.27	24
25	19. 1	9.10	1.43	13. 6	20.54	23.25	19.45	10.53	0.44	12. 1	20.44	23.25	25
26	18.46	8.48	2. 7	13.26	21. 5	23.24	19.32	10.33	1. 8	12.22	20.55	23.24	26
27	18.31	8.25	2.30	13.45	21.15	23.22	19.19	10.11	1.31	12.43	21. 6	23.21	27
28	18.15	8. 3	2.54	14. 4	21.25	23.19	19. 5	9.50	1.55	13. 3	21.17	23.19	28
29	17.59		3.17	14.23	21.35	23.16	18.51	9.29	2.18	13.23	21.28	23.15	29
30	17.43		3.40	14.41	21.44	23.13	18.37	9. 8	2.41	13.43	21.38	23.12	30
31	17.26		4. 4		21.53		18.22	8.46		14. 3		23. 8	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1826,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1830, 1834.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days
	Add to ap. time M. S.	Add to ap. time M. S.	Add to ap. time M. S.	Add to ap. time M. S.	Sub. fr. ap. time M. S.	Sub. fr. ap. time M. S.	Add to ap. time M. S.	Add to ap. time M. S.	Sub. fr. ap. time M. S.	Sub. fr. ap. time M. S.	Sub. fr. ap. time M. S.	Sub. fr. ap. time M. S.	
1	3.50	13.56	12.41	4. 3	3. 3	2.40	3.17	3.24	0. 2	10.14	10.14	10.48	1
2	4.18	14. 4	12.29	3.44	3.11	2.30	3.39	3.55	0.22	10.33	10.15	10.25	2
3	4.46	14.10	12.16	3.26	3.10	2.21	3.40	3.51	0.42	10.51	10.16	10. 1	3
4	5.14	14.15	12. 3	3. 8	3.24	2.11	3.51	3.46	1. 1	11. 9	10.15	9.59	4
5	5.41	14.27	11.50	2.51	3.30	2. 1	4. 2	3.41	1.21	11.27	10.14	9.45	5
6	6. 8	14.28	11.36	2.33	3.36	1.51	4.13	3.35	1.40	11.45	10.11	9.27	6
7	6.34	14.30	11.21	2.16	3.40	1.40	4.23	3.26	2. 0	12. 2	10. 8	9.22	7
8	7.00	14.32	11. 7	1.56	3.44	1.29	4.33	3.21	2.27	12.19	10. 4	9.36	8
9	7.25	14.34	10.51	1.42	3.48	1.17	4.42	3.14	2.41	12.35	10. 0	9.29	9
10	7.50	14.36	10.35	1.25	3.51	1. 8	4.51	3. 5	3. 1	12.51	10.34	9.25	10
11	8.14	14.36	10.20	1. 8	3.53	0.54	4.59	4.07	3.22	13. 7	10.48	9.34	11
12	8.38	14.36	10. 4	0.52	3.55	0.42	5. 2	4.17	3.43	13.22	10.41	9. 6	12
13	9. 1	14.35	9.49	0.36	3.56	0.29	5.13	4.27	4. 4	13.38	10.32	8.58	13
14	9.23	14.35	9.31	0.21	3.57	0.17	5.22	4.37	4.26	13.51	10.24	8.40	14
15	9.44	14.30	9.14	0. 8	3.57	0. 3	5.29	4.45	4.46	14. 4	10.14	8.21	15
16	10. 5	14.29	8.55	0.10	3.57	0.00	5.35	4. 4	5. 7	14.17	10. 4	8.12	16
17	10.26	14.27	8.39	0.24	3.56	0.21	5.40	3.52	5.29	14.30	10.02	8.05	17
18	10.45	14.17	8.21	0.34	3.55	0.34	5.46	3.38	5.44	14.41	10.40	8.13	18
19	11. 4	14.12	8. 3	0.52	3.53	0.46	5.50	3.25	6.10	14.52	10.27	8.05	19
20	11.22	14. 5	7.45	1. 1	3.50	0.54	5.54	3.12	6.31	15. 2	10.15	8.00	20
21	11.39	13.54	7.27	1.11	3.47	1.12	5.57	2.64	6.52	15.13	10.00	7.54	21
22	11.55	13.51	7. 8	1. 1	3.44	1.24	6. 0	2.43	7.12	15.22	10.03	7.48	22
23	12.11	13.43	6.50	1.44	3.40	1.38	6. 3	2.23	7.34	15.31	10.27	7.42	23
24	12.28	13.34	6.31	1.53	3.35	1.51	6. 4	2.13	7.56	15.39	10. 9	7.35	24
25	12.40	13.24	6.13	2. 7	3.30	2. 3	6. 6	2.07	8.15	15.46	10.00	7.28	25
26	12.55	13.16	5.54	2.17	3.24	2.16	6. 6	1.41	8.29	15.52	10.03	7.22	26
27	13. 5	13. 4	5.35	2.39	3.16	2.29	6. 6	1.24	8.56	16.04	10.13	7.17	27
28	13.17	13.07	5.17	2.57	3.11	2.41	6. 5	1. 7	9.15	16. 5	10.55	7.12	28
29	13.28		4.59	2.40	3. 4	2.53	6. 5	0.50	9.35	16. 7	11.22	7.07	29
30	13.39		4.39	2.26	2.58	3. 5	6. 3	0.39	9.56	16.10	11.10	7.02	30
31	13.47		4.21		2.49		6. 1	0.14		16.18		7.00	31

TABLE IV. THE SUN'S DECLINATION

71

FOR THE YEAR 1827,
WHICH WILL ANSWER NEARLY FOR THE YEARS 1831, 1835.

DAYS.	Jan. South.	Feb. South.	March. South.	April. North.	May. North.	June. North.	July. North.	Aug. North.	Sept. North.	Oct. South.	Nov. South.	Dec. South.	DAYS.
1	23. 3	17.14	7.45	4.21	14.56	22.00	23.10	18.11	8.29	2.59	14.17	21.45	1
2	22.58	16.57	7.23	4.45	15.14	22. 8	23. 6	17.56	8. 8	3.22	14.36	21.54	2
3	22.53	16.39	7.00	5. 8	15.32	22.16	23. 2	17.40	7.46	3.46	14.55	22. 3	3
4	22.47	16.21	6.37	5.31	15.49	22.23	22.57	17.25	7.24	4. 9	15.14	22.12	4
5	22.41	16. 3	6.14	5.53	16. 7	22.30	22.52	17. 9	7. 2	4.32	15.33	22.20	5
6	22.34	15.45	5.50	6.16	16.24	22.37	22.46	16.52	6.39	4.55	15.51	22.27	6
7	22.26	15.27	5.27	6.39	16.41	22.43	22.40	16.36	6.17	5.18	16. 9	22.35	7
8	22.19	15. 8	5. 4	7. 1	16.57	22.49	22.34	16.19	5.54	5.41	16.27	22.41	8
9	22.11	14.49	4.41	7.24	17.13	22.54	22.27	16. 2	5.32	6. 4	16.44	22.48	9
10	22. 2	14.30	4.17	7.46	17.29	22.59	22.20	15.45	5. 9	6.27	17. 1	22.53	10
11	21.53	14.10	3.54	8. 8	17.45	23. 4	22.12	15.27	4.46	6.50	17.18	22.59	11
12	21.44	13.50	3.30	8.30	18.00	23. 8	22. 4	15.10	4.24	7.13	17.35	23. 4	12
13	21.34	13.30	3. 6	8.52	18.16	23.12	21.56	14.51	4. 1	7.35	17.51	23. 8	13
14	21.23	13.10	2.43	9.14	18.30	23.15	21.47	14.33	3.38	7.58	18. 7	23.12	14
15	21.13	12.50	2.19	9.35	18.45	23.18	21.38	14.15	3.15	8.20	18.23	23.16	15
16	21. 2	12.29	1.56	9.57	18.59	23.21	21.29	13.56	2.51	8.42	18.38	23.19	16
17	20.50	12. 8	1.32	10.15	19.13	23.23	21.19	13.37	2.28	9. 4	18.53	23.22	17
18	20.38	11.47	1. 8	10.39	19.26	23.25	21. 9	13.18	2. 5	9.26	19. 8	23.24	18
19	20.26	11.26	0.44	11.00	19.40	23.26	20.58	12.58	1.42	9.49	19.22	23.25	19
20	20.13	11. 5	0.21S	11.21	19.53	23.27	20.47	12.39	1.18	10.10	19.36	23.27	20
21	20.00	10.43	0. 3N	11.41	20. 5	23.28	20.36	12.19	0.55	10.32	19.50	23.27	21
22	19.47	10.21	0.27	12. 2	20.17	23.28	20.25	11.59	0.32	10.53	20. 3	23.23	22
23	19.33	10.00	0.50	12.22	20.29	23.27	20.13	11.39	0. 8N	11.14	20.16	23.27	23
24	19.19	9.38	1.14	12.42	20.41	23.27	20.00	11.18	0.15S	11.35	20.28	23.27	24
25	19. 5	9.15	1.38	13. 2	20.52	23.25	19.48	10.58	0.39	11.56	20.41	23.26	25
26	18.50	8.53	2. 1	13.21	21. 3	23.24	19.35	10.37	1. 2	12.17	20.52	23.24	26
27	18.34	8.31	2.25	13.40	21.13	23.22	19.22	10.16	1.26	12.38	21. 4	23.22	27
28	18.19	8. 8	2.48	14.00	21.23	23.20	19. 8	9.55	1.49	12.58	21.15	23.19	28
29	18. 3		3.12	14.18	21.33	23.17	18.54	9.34	2.12	13.18	21.25	23.16	29
30	17.47		3.35	14.37	21.42	23.14	18.40	9.13	2.36	13.38	21.35	23.13	30
31	17.30		3.58		21.51		18.26	8.51		13.58		23. 9	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1827,
WHICH WILL ANSWER NEARLY FOR THE YEARS 1831, 1835.

DAYS.	Jan. Add to ap. tim M. S.	Feb. Add to ap. tim M. S.	March. Add to ap. tim M. S.	April. Add to ap. tim M. S.	May. Sub. fr. ap. tim M. S.	June. Sub. fr. ap. tim M. S.	July. Add to ap. tim M. S.	Aug. Add to ap. tim M. S.	Sept. Add to ap. tim M. S.	Oct. Sub. fr. ap. tim M. S.	Nov. Sub. fr. ap. tim M. S.	Dec. Sub. fr. ap. tim M. S.	DAYS.
1	3.43	13.51	12.44	4. 9	2.53	2.34	3.17	6. 1	0. 1	10. 8	16.14	10.54	1
2	4.11	14. 2	12.32	3.50	3. 7	2.30	3.24	5.58	sub0.18	10.28	16.16	10.51	2
3	4.40	14. 9	12.20	3.32	3.14	2.20	3.40	5.53	0.37	10.47	16.16	10. 8	3
4	5. 7	14.15	12. 7	3.14	3.20	2.11	3.51	5.49	0.56	11. 5	16.16	9.44	4
5	5.34	14.21	11.54	2.56	3.27	2. 1	4. 2	5.43	1.16	11.23	16.15	9.20	5
6	6. 1	14.25	11.40	2.39	3.32	1.57	4.12	5.38	1.35	11.41	16.13	8.55	6
7	6.28	14.29	11.25	2.21	3.37	1.40	4.22	5.31	1.54	11.59	16.11	8.30	7
8	6.52	14.32	11.11	2. 4	3.41	1.24	4.32	5.24	2.16	12.16	16. 7	8. 3	8
9	7.19	14.34	10.56	1.47	3.45	1.18	4.41	5.16	2.36	12.32	16. 2	7.37	9
10	7.48	14.35	10.40	1.30	3.47	1. 7	4.50	5. 8	2.57	12.49	15.57	7.10	10
11	8. 3	14.35	10.24	1.13	3.51	0.55	4.59	4.59	3.17	13. 4	15.51	6.42	11
12	8.51	14.35	10. 8	0.57	3.50	0.43	5. 7	4.50	3.38	13.19	15.44	6.15	12
13	8.54	14.34	9.51	0.41	3.55	0.31	5.14	4.40	3.56	13.34	15.36	5.46	13
14	9.16	14.32	9.35	0.25	3.56	0.19	5.21	4.30	4.20	13.48	15.27	5.18	14
15	9.38	14.29	9.18	0. 9	3.57	0. 6	5.28	4.19	4.41	14. 1	15.18	4.49	15
16	9.53	14.26	9. 0	sub0. 1	3.56	add0. 6	5.34	4. 7	5. 2	14.14	15. 7	4.20	16
17	10.14	14.22	8.43	0.20	3.56	0.13	5.40	3.55	5.23	14.27	14.56	3.50	17
18	10.34	14.17	8.25	0.35	3.54	0.32	5.46	3.43	5.44	14.34	14.44	3.20	18
19	10.52	14.12	8. 7	0.49	3.52	0.45	5.50	3.30	6. 5	14.50	14.31	2.51	19
20	11.16	14. 1	7.49	1. 2	3.50	0.58	5.55	3.16	6.26	15. 0	14.17	2.21	20
21	11.38	13.54	7.31	1.15	3.47	1.11	5.53	3. 3	6.47	15.10	14. 2	1.51	21
22	11.54	13.52	7.13	1.27	3.43	1.24	6. 2	2.48	7. 7	15.20	13.47	1.21	22
23	12. 6	13.44	6.54	1.40	3.38	1.37	6. 4	2.35	7.22	15.28	13.30	0.50	23
24	12.21	13.36	6.38	1.51	3.34	1.50	6. 6	2.18	7.49	15.36	13.13	0.20	24
25	12.30	13.27	6.18	2. 2	3.29	2. 3	6. 8	2. 2	8. 9	15.44	12.56	add0.10	25
26	12.44	13.17	5.59	2.15	3.23	2.16	6. 9	1.47	8.30	15.50	12.37	0.40	26
27	13. 2	13. 7	5.41	2.23	3.17	2.29	6. 9	1.30	8.50	15.56	12.18	1.10	27
28	13.14	12.50	5.22	2.33	3.10	2.41	6. 9	1.13	9.10	16. 1	11.58	1.39	28
29	13.26		5. 4	2.42	3. 9	2.53	6. 7	0.55	9.30	16. 6	11.37	2. 9	29
30	13.34		4.45	2.51	2.55	3. 5	6. 6	0.37	9.49	16. 7	11.16	2.58	30
31	13.48		4.27		2.47		6. 1	0.20		15.12		2. 7	31

TABLE V.

For reducing the Sun's DECLINATION as given in the Nautical Almanac for noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add. bef. N.	H.M. 0 20 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	H.M. 1. 0 1 20 1. 40	Sub. aft. N. Add. bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add. in E.	5 Deg.	10 Deg.	15 Deg.	20 Deg.	25 Deg.	30 Deg.	35 Deg.	40 Deg.	Sub. in W. Add. in E.	Add in W. Sub. in E.	
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days	Days.	
Decemb. 21	Decemb. 21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21 June	21 June	
20	22	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	22	20	
19	23	0.0	0.1	0.2	0.2	0.3	0.4	0.5	0.6	23	19	
18	24	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	24	18	
17	25	0.1	0.3	0.4	0.6	0.7	0.9	0.11	0.12	25	17	
16	26	0.2	0.4	0.5	0.7	0.9	0.11	0.13	0.15	26	16	
15	27	0.2	0.5	0.6	0.8	0.11	0.13	0.15	0.18	27	15	
14	28	0.3	0.6	0.7	0.10	0.12	0.15	0.18	0.21	28	14	
13	29	0.3	0.7	0.9	0.12	0.15	0.18	0.21	0.24	29	13	
12	30	0.3	0.7	0.10	0.13	0.17	0.20	0.23	0.27	30 June	12	
11	Decemb. 31	0.4	0.8	0.11	0.15	0.19	0.22	0.26	0.30	1 July	11	
10	1	0.4	0.8	0.12	0.16	0.20	0.24	0.28	0.32	2	10	
9	2	0.4	0.8	0.13	0.17	0.21	0.25	0.30	0.35	3	9	
8	3	0.5	0.9	0.14	0.19	0.24	0.29	0.33	0.38	4	8	
7	4	0.5	0.10	0.15	0.21	0.26	0.31	0.36	0.41	5	7	
6	5	0.5	0.11	0.16	0.22	0.28	0.33	0.38	0.44	6	6	
5	6	0.6	0.12	0.17	0.24	0.30	0.35	0.41	0.47	7	5	
4	7	0.6	0.12	0.18	0.25	0.31	0.37	0.43	0.49	8	4	
3	8	0.6	0.13	0.19	0.26	0.33	0.39	0.45	0.52	9	3	
2	9	0.7	0.14	0.20	0.27	0.34	0.41	0.48	0.56	10	2	
Decemb. 1	10	0.7	0.14	0.21	0.29	0.36	0.43	0.50	0.57	11	1 June	
Novemb. 30	11	0.7	0.15	0.22	0.30	0.37	0.45	0.52	1.0	12	31 May	
29	12	0.8	0.15	0.23	0.31	0.39	0.47	0.55	1.0	13	30	
28	13	0.8	0.16	0.24	0.32	0.41	0.49	0.57	1.0	14	29	
27	14	0.8	0.17	0.25	0.34	0.42	0.51	0.59	1.0	15	28	
26	15	0.9	0.18	0.26	0.35	0.44	0.53	1.0	1.1	16	27	
25	16	0.9	0.18	0.27	0.37	0.46	0.55	1.0	1.1	17	26	
24	17	0.9	0.19	0.28	0.38	0.47	0.57	1.0	1.1	18	25	
23	18	0.10	0.20	0.29	0.39	0.49	0.59	1.0	1.1	19	24	
22	19	0.10	0.20	0.30	0.40	0.50	1.0	1.1	1.2	20	23	
21	20	0.10	0.21	0.31	0.41	0.51	1.0	1.1	1.2	21	22	
20	21	0.11	0.22	0.32	0.42	0.53	1.0	1.1	1.2	22	21	
19	22	0.11	0.22	0.33	0.44	0.55	1.0	1.1	1.2	23	20	
18	23	0.11	0.23	0.34	0.45	0.56	1.0	1.1	1.2	24	19	
17	24	0.12	0.23	0.34	0.46	0.57	1.0	1.2	1.3	25	18	
16	25	0.12	0.24	0.35	0.47	0.59	1.1	1.2	1.3	26	17	
15	26	0.12	0.24	0.36	0.48	1.0	1.1	1.2	1.3	27	16	
14	27	0.12	0.25	0.37	0.49	1.0	1.2	1.2	1.3	28	15	
13	28	0.13	0.26	0.38	0.51	1.0	1.2	1.2	1.4	29	14	
12	29	0.13	0.26	0.39	0.52	1.0	1.2	1.3	1.4	30	13	
11	30	0.13	0.27	0.40	0.53	1.0	1.2	1.3	1.4	31 July	12	
9	February 1	0.13	0.27	0.41	0.55	1.0	1.2	1.3	1.5	2 August	10	
7	2	0.14	0.28	0.42	0.57	1.1	1.2	1.3	1.5	3	8	
5	3	0.14	0.29	0.43	0.58	1.1	1.2	1.4	1.5	4	6	
3	4	0.15	0.30	0.45	1.0	1.1	1.3	1.4	1.5	5	4	
Novemb. 1	5	0.15	0.31	0.46	1.0	1.1	1.3	1.4	1.5	6	3 May	
October 30	6	0.16	0.32	0.47	1.0	1.1	1.3	1.5	1.6	7	20 April	
29	7	0.16	0.32	0.48	1.0	1.2	1.3	1.5	1.6	8	19	
28	8	0.16	0.33	0.49	1.0	1.2	1.3	1.5	1.6	9	18	
27	9	0.17	0.34	0.50	1.0	1.2	1.4	1.5	1.6	10	17	
26	10	0.17	0.34	0.51	1.0	1.2	1.4	1.5	1.6	11	16	
25	11	0.17	0.35	0.52	1.1	1.2	1.4	1.5	1.6	12	15	
24	12	0.18	0.36	0.53	1.1	1.3	1.4	1.5	1.6	13	14	
23	13	0.18	0.37	0.54	1.1	1.3	1.5	1.6	1.6	14	13	
22	14	0.19	0.38	0.55	1.1	1.3	1.5	1.6	1.6	15	12	
21	15	0.19	0.39	0.56	1.1	1.3	1.5	1.6	1.6	16	11	
20	16	0.19	0.39	0.57	1.1	1.3	1.5	1.6	1.6	17	10	
19	17	0.19	0.39	0.58	1.1	1.3	1.5	1.6	1.6	18	9	
18	18	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	19	8	
17	19	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	20	7	
16	20	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	21	6	
15	21	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	22	5	
14	22	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	23	4	
13	23	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	24	3	
12	24	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	25	2	
11	25	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	26	1	
10	26	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	27	31 Dec.	
9	27	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	28	30 Dec.	
8	28	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	29	29 Dec.	
7	29	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	30	28 Dec.	
6	30	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	31	27 Dec.	
5	31	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	1	26 Dec.	
4	1	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	2	25 Dec.	
3	2	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	3	24 Dec.	
2	3	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	4	23 Dec.	
1	4	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	5	22 Dec.	
After Equinox.	Before Equinox.	0.20	0.40	0.59	1.1	1.3	1.5	1.6	1.6	Before Equinox.	After Equinox.	

TABLE V.

78

For reducing the Sun's DECLINATION as given in the Nautical Almanac for noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	45 Deg.	50 Deg.	55 Deg.	60 Deg.	65 Deg.	70 Deg.	75 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 31	Decemb. 21	0 0	0 0	0 0	0 0	0 0	0 0	0 0	21 June	21 June
20	22	0 3	0 3	0 4	0 4	0 4	0 5	0 5	22	20
19	23	0 6	0 7	0 8	0 9	0 9	0 10	0 11	23	19
18	24	0 10	0 11	0 12	0 13	0 14	0 15	0 16	24	18
17	25	0 13	0 15	0 16	0 18	0 19	0 20	0 22	25	17
16	26	0 16	0 18	0 20	0 22	0 24	0 26	0 27	26	16
15	27	0 20	0 22	0 24	0 26	0 29	0 31	0 33	27	15
14	28	0 23	0 25	0 28	0 31	0 34	0 36	0 38	28	14
13	29	0 26	0 29	0 32	0 35	0 38	0 41	0 44	29	13
12	30	0 30	0 33	0 36	0 40	0 43	0 46	0 50	30 June	12
11	Decemb. 31	0 33	0 37	0 40	0 44	0 48	0 51	0 55	1 July	11
10	January 1	0 36	0 40	0 44	0 48	0 53	0 57	1 1	2	10
9	2	0 39	0 44	0 48	0 53	0 57	1 2	1 6	3	9
8	3	0 43	0 46	0 53	0 57	1 2	1 7	1 11	4	8
7	4	0 46	0 51	0 55	1 1	1 7	1 12	1 17	5	7
6	5	0 49	0 55	1 0	1 6	1 11	1 17	1 22	6	6
5	6	0 52	0 58	1 4	1 10	1 16	1 22	1 27	7	5
4	7	0 55	1 1	1 7	1 14	1 20	1 26	1 32	8	4
3	8	0 58	1 5	1 11	1 18	1 24	1 31	1 37	9	3
2	9	1 1	1 8	1 15	1 22	1 29	1 36	1 43	10	2
Decemb. 1	10	1 4	1 12	1 19	1 26	1 33	1 41	1 48	11	1 June
Novemb. 30	11	1 7	1 16	1 23	1 30	1 37	1 45	1 52	12	31 May
29	12	1 10	1 18	1 26	1 34	1 42	1 50	1 57	13	30
28	13	1 13	1 22	1 30	1 38	1 46	1 54	2 2	14	29
27	14	1 16	1 25	1 34	1 42	1 50	1 58	2 7	15	28
26	15	1 19	1 28	1 37	1 46	1 55	2 3	2 12	16	27
25	16	1 22	1 31	1 40	1 49	1 59	2 8	2 17	17	26
24	17	1 25	1 35	1 44	1 53	2 3	2 12	2 21	18	25
23	18	1 28	1 38	1 47	1 57	2 7	2 16	2 26	19	24
22	19	1 30	1 41	1 51	2 1	2 11	2 21	2 31	20	23
21	20	1 33	1 44	1 54	2 4	2 15	2 25	2 35	21	22
20	21	1 36	1 47	1 57	2 8	2 19	2 29	2 40	22	21
19	22	1 39	1 50	2 0	2 11	2 22	2 33	2 44	23	20
18	23	1 41	1 53	2 4	2 15	2 26	2 37	2 48	24	19
17	24	1 43	1 55	2 7	2 18	2 30	2 41	2 52	25	18
16	25	1 46	1 58	2 10	2 21	2 33	2 45	2 56	26	17
15	26	1 48	2 1	2 13	2 26	2 37	2 49	3 1	27	16
14	27	1 51	2 4	2 16	2 28	2 40	2 52	3 5	28	15
13	28	1 54	2 7	2 19	2 31	2 44	2 56	3 9	29	14
12	29	1 56	2 11	2 24	2 37	2 51	3 4	3 17	31 July	12
11	January 30	1 58	2 11	2 24	2 37	2 51	3 4	3 17	31	11
10	February 1	2 3	2 17	2 30	2 43	2 57	3 11	3 24	2 August	10
9	2	2 7	2 21	2 35	2 49	3 3	3 17	3 32	4	9
8	3	2 11	2 25	2 40	2 54	3 9	3 23	3 38	5	8
7	4	2 14	2 29	2 44	2 59	3 14	3 29	3 44	6	7
6	5	2 18	2 33	2 49	3 4	3 19	3 35	3 50	10	6
5	6	2 22	2 38	2 53	3 9	3 25	3 41	3 56	12	5
4	7	2 25	2 41	2 58	3 14	3 30	3 46	4 3	14	4
3	8	2 29	2 45	3 9	3 18	3 35	3 51	4 8	16	3
2	9	2 32	2 49	3 5	3 22	3 39	3 56	4 13	18	2
1	10	2 36	2 53	3 11	3 28	3 45	4 3	4 20	21	1
Decemb. 31	21	2 40	2 56	3 16	3 33	3 51	4 8	4 26	24	Decemb. 31
30	22	2 43	3 1	3 20	3 38	3 56	4 14	4 32	27	30
29	23	2 46	3 5	3 23	3 42	4 1	4 19	4 38	30 August	29
28	24	2 49	3 8	3 26	3 45	4 4	4 23	4 41	2 Sept	28
27	25	2 51	3 10	3 29	3 48	4 7	4 26	4 45	5	27
26	26	2 53	3 13	3 32	3 51	4 10	4 29	4 49	8	26
25	27	2 56	3 14	3 35	3 53	4 13	4 32	4 51	11	25
24	28	2 56	3 15	3 34	3 54	4 14	4 33	4 52	14	24
23	29	2 56	3 15	3 35	3 55	4 15	4 33	4 52	17	23
22	30	2 56	3 15	3 35	3 55	4 15	4 34	4 53	Before Equinox.	22
21	31	2 56	3 15	3 35	3 55	4 15	4 34	4 53	After Equinox.	21

K TAB.

TABLE V.

For reducing the SUN'S DECLINATION as given in the Nautical Almanac for noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M. 5. 20	H.M. 5. 40	H.M. 6. 0	H.M. 6. 20	H.M. 6. 40	H.M. 7. 0	H.M. 7. 20	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	80 Deg.	85 Deg.	90 Deg.	95 Deg.	100 Deg.	105 Deg.	110 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 5	0. 6	0. 6	0. 7	0. 8	0. 8	0. 8	22	20
19	23	0. 11	0. 12	0. 13	0. 14	0. 15	0. 15	0. 16	23	19
18	24	0. 17	0. 19	0. 20	0. 21	0. 22	0. 23	0. 24	24	18
17	25	0. 23	0. 25	0. 26	0. 28	0. 29	0. 31	0. 32	25	17
16	26	0. 29	0. 31	0. 33	0. 35	0. 37	0. 38	0. 40	26	16
15	27	0. 35	0. 38	0. 41	0. 42	0. 44	0. 46	0. 49	27	15
14	28	0. 41	0. 43	0. 46	0. 49	0. 51	0. 54	0. 57	28	14
13	29	0. 47	0. 50	0. 53	0. 56	0. 59	1. 2	1. 5	29	13
12	30	0. 53	0. 56	0. 59	1. 3	1. 6	1. 9	1. 12	30 June	12
11	Decemb. 31	0. 59	1. 2	1. 6	1. 10	1. 13	1. 17	1. 21	1 July	11
10	January 1	1. 5	1. 9	1. 13	1. 17	1. 21	1. 25	1. 29	2	10
9	2	1. 11	1. 15	1. 19	1. 24	1. 28	1. 32	1. 37	3	9
8	3	1. 16	1. 21	1. 26	1. 31	1. 35	1. 40	1. 45	4	8
7	4	1. 22	1. 27	1. 32	1. 37	1. 42	1. 47	1. 53	5	7
6	5	1. 27	1. 33	1. 38	1. 44	1. 49	1. 54	2. 0	6	6
5	6	1. 33	1. 39	1. 45	1. 51	1. 57	2. 2	2. 6	7	5
4	7	1. 39	1. 45	1. 51	1. 57	2. 3	2. 9	2. 16	8	4
3	8	1. 44	1. 50	1. 57	2. 4	2. 10	2. 16	2. 23	9	3
2	9	1. 50	1. 56	2. 3	2. 10	2. 17	2. 23	2. 30	10	2
Decemb. 1	10	1. 55	2. 2	2. 9	2. 16	2. 23	2. 30	2. 38	11	1 June
Novemb. 30	11	2. 0	2. 7	2. 15	2. 22	2. 30	2. 37	2. 46	12	31 May
29	12	2. 6	2. 13	2. 21	2. 29	2. 37	2. 44	2. 52	13	30
28	13	2. 10	2. 19	2. 27	2. 35	2. 43	2. 51	3. 0	14	29
27	14	2. 16	2. 25	2. 33	2. 42	2. 50	2. 58	3. 7	15	28
26	15	2. 21	2. 30	2. 38	2. 47	2. 56	3. 5	3. 13	16	27
25	16	2. 26	2. 35	2. 44	2. 53	3. 2	3. 11	3. 21	17	26
24	17	2. 31	2. 40	2. 50	2. 59	3. 9	3. 18	3. 28	18	25
23	18	2. 36	2. 46	2. 55	3. 5	3. 15	3. 24	3. 34	19	24
22	19	2. 41	2. 51	3. 1	3. 11	3. 21	3. 31	3. 41	20	23
21	20	2. 46	2. 56	3. 6	3. 17	3. 27	3. 37	3. 48	21	22
20	21	2. 50	3. 2	3. 12	3. 23	3. 33	3. 44	3. 55	22	21
19	22	2. 55	3. 6	3. 17	3. 28	3. 39	3. 50	4. 1	23	20
18	23	3. 0	3. 11	3. 22	3. 33	3. 45	3. 56	4. 7	24	19
17	24	3. 4	3. 16	3. 27	3. 39	3. 50	4. 1	4. 13	25	18
16	25	3. 8	3. 20	3. 32	3. 44	3. 56	4. 7	4. 19	26	17
15	26	3. 13	3. 25	3. 37	3. 49	4. 1	4. 13	4. 26	27	16
14	27	3. 17	3. 29	3. 42	3. 54	4. 6	4. 19	4. 31	28	15
13	28	3. 22	3. 34	3. 47	4. 0	4. 12	4. 26	4. 39	29	14
12	29	3. 28	3. 43	3. 56	4. 9	4. 22	4. 36	4. 49	30	13
11	January 30	3. 33	3. 43	3. 56	4. 9	4. 22	4. 36	4. 49	31 July	12
10	February 1	3. 38	3. 51	4. 5	4. 18	4. 32	4. 46	4. 59	2 August	11
9	2	3. 43	4. 0	4. 14	4. 28	4. 42	4. 56	5. 10	3	10
8	3	3. 52	4. 6	4. 21	4. 36	4. 50	5. 5	5. 19	4	9
7	4	3. 59	4. 14	4. 29	4. 44	4. 59	5. 14	5. 29	5	8
6	5	4. 5	4. 21	4. 36	4. 52	5. 7	5. 23	5. 38	6	7
5	6	4. 12	4. 28	4. 44	5. 0	5. 16	5. 31	5. 47	7	6
4	7	4. 19	4. 35	4. 51	5. 7	5. 23	5. 40	5. 56	8	5
3	8	4. 24	4. 41	4. 57	5. 14	5. 30	5. 47	6. 3	9	4
2	9	4. 30	4. 47	5. 3	5. 21	5. 38	5. 55	6. 12	10	3
1	10	4. 37	4. 55	5. 12	5. 29	5. 47	6. 4	6. 21	11	2
Decemb. 18	23	4. 44	5. 2	5. 19	5. 37	5. 55	6. 13	6. 31	12	1
16	25	4. 50	5. 8	5. 25	5. 44	6. 2	6. 20	6. 39	13	31
14	27	4. 56	5. 15	5. 33	5. 52	6. 10	6. 29	6. 47	14	30
12	29	5. 0	5. 19	5. 38	5. 57	6. 16	6. 34	6. 53	15	29
10	31	5. 4	5. 23	5. 42	6. 1	6. 20	6. 39	6. 58	16	28
9	1	5. 8	5. 27	5. 46	6. 5	6. 25	6. 44	7. 3	17	27
8	2	5. 11	5. 30	5. 49	6. 8	6. 28	6. 47	7. 6	18	26
7	3	5. 12	5. 31	5. 51	6. 11	6. 31	6. 50	7. 9	19	25
6	4	5. 12	5. 32	5. 52	6. 12	6. 32	6. 51	7. 11	20	24
5	5	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	21	23
4	6	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	22	22
3	7	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	23	21
2	8	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	24	20
1	9	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	25	19
Decemb. 1	10	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	26	18
Novemb. 30	11	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	27	17
29	12	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	28	16
28	13	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	29	15
27	14	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	30	14
26	15	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	31	13
25	16	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	1	12
24	17	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	2	11
23	18	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	3	10
22	19	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	4	9
21	20	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	5	8
20	21	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	6	7
19	22	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	7	6
18	23	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	8	5
17	24	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	9	4
16	25	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	10	3
15	26	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	11	2
14	27	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	12	1
13	28	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	13	31
12	29	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	14	30
11	30	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	15	29
10	31	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	16	28
9	1	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	17	27
8	2	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	18	26
7	3	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	19	25
6	4	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	20	24
5	5	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	21	23
4	6	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	22	22
3	7	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	23	21
2	8	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	24	20
1	9	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	25	19
Decemb. 1	10	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	26	18
Novemb. 30	11	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	27	17
29	12	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	28	16
28	13	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	29	15
27	14	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	30	14
26	15	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	31	13
25	16	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	1	12
24	17	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	2	11
23	18	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	3	10
22	19	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	4	9
21	20	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	5	8
20	21	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	6	7
19	22	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	7	6
18	23	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	8	5
17	24	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	9	4
16	25	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	10	3
15	26	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	11	2
14	27	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	12	1
13	28	5. 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	13	31
12	29	5. 13	5. 33	5. 53	6. 13					

TABLE V.

75

For reducing the Sun's DECLINATION as given in the Nautical Almanac for noon at GREENWICH, to any other Time under any other Meridian

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	115 Deg.	120 Deg.	125 Deg.	130 Deg.	135 Deg.	140 Deg.	145 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.	
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.	
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June	
20	22	0. 9	0. 9	0. 9	0. 10	0. 10	0. 10	0. 10	22	20	
19	23	0. 17	0. 18	0. 18	0. 19	0. 19	0. 20	0. 21	23	19	
18	24	0. 25	0. 26	0. 27	0. 28	0. 29	0. 30	0. 31	24	18	
17	25	0. 34	0. 35	0. 36	0. 38	0. 39	0. 41	0. 43	25	17	
16	26	0. 42	0. 44	0. 46	0. 48	0. 49	0. 51	0. 53	26	16	
15	27	0. 51	0. 53	0. 55	0. 57	0. 59	1. 1	1. 3	27	15	
14	28	0. 59	1. 2	1. 5	1. 7	1. 9	1. 12	1. 14	28	14	
13	29	1. 8	1. 11	1. 14	1. 17	1. 19	1. 22	1. 25	29	13	
12	30	1. 16	1. 19	1. 23	1. 26	1. 29	1. 32	1. 35	30 June	12	
11	Decemb. 31	1. 24	1. 28	1. 32	1. 35	1. 39	1. 43	1. 46	1 July	11	
10	January 1	1. 33	1. 37	1. 41	1. 45	1. 49	1. 53	1. 57	2	10	
9	2	1. 42	1. 46	1. 51	1. 56	1. 59	2. 3	2. 7	3	9	
8	3	1. 49	1. 54	1. 59	2. 4	2. 9	2. 13	2. 18	4	8	
7	4	1. 58	2. 3	2. 8	2. 13	2. 19	2. 23	2. 28	5	7	
6	5	2. 5	2. 11	2. 16	2. 22	2. 28	2. 33	2. 39	6	6	
5	6	2. 14	2. 20	2. 26	2. 32	2. 38	2. 43	2. 49	7	5	
4	7	2. 22	2. 28	2. 34	2. 41	2. 47	2. 53	2. 59	8	4	
3	8	2. 29	2. 36	2. 43	2. 49	2. 56	3. 3	3. 9	9	3	
2	9	2. 37	2. 44	2. 51	2. 58	3. 5	3. 12	3. 19	10	2	
Decemb. 1	10	2. 45	2. 52	2. 59	3. 6	3. 14	3. 21	3. 28	11	1 June	
Novemb. 30	11	2. 52	3. 0	3. 7	3. 15	3. 23	3. 30	3. 38	12	31 May	
29	12	3. 0	3. 8	3. 16	3. 24	3. 32	3. 39	3. 47	13	30	
28	13	3. 8	3. 16	3. 24	3. 32	3. 40	3. 49	3. 57	14	29	
27	14	3. 15	3. 24	3. 32	3. 41	3. 49	3. 58	4. 6	15	28	
26	15	3. 22	3. 31	3. 40	3. 49	3. 58	4. 7	4. 16	16	27	
25	16	3. 30	3. 39	3. 48	3. 57	4. 7	4. 16	4. 25	17	26	
24	17	3. 37	3. 46	3. 55	4. 6	4. 16	4. 24	4. 34	18	25	
23	18	3. 44	3. 54	4. 4	4. 14	4. 24	4. 33	4. 43	19	24	
22	19	3. 51	4. 1	4. 11	4. 21	4. 31	4. 41	4. 51	20	23	
21	20	3. 58	4. 8	4. 19	4. 29	4. 39	4. 50	5. 0	21	22	
20	21	4. 5	4. 16	4. 27	4. 37	4. 48	4. 59	5. 9	22	21	
19	22	4. 12	4. 23	4. 34	4. 45	4. 56	5. 7	5. 18	23	20	
18	23	4. 19	4. 30	4. 41	4. 53	5. 4	5. 15	5. 26	24	19	
17	24	4. 25	4. 36	4. 48	5. 0	5. 12	5. 23	5. 34	25	18	
16	25	4. 31	4. 43	4. 55	5. 7	5. 19	5. 30	5. 42	26	17	
15	26	4. 38	4. 50	5. 2	5. 14	5. 26	5. 38	5. 50	27	16	
14	27	4. 43	4. 56	5. 8	5. 21	5. 33	5. 46	5. 58	28	15	
13	28	4. 50	5. 3	5. 16	5. 28	5. 40	5. 54	6. 6	29	14	
12	29	5. 2	5. 15	5. 28	5. 41	5. 54	6. 8	6. 21	31 July	12	
9	February 1	5. 13	5. 27	5. 40	5. 54	6. 8	6. 22	6. 35	2 August	10	
7	3	5. 24	5. 38	5. 52	6. 6	6. 20	6. 35	6. 49	4	8	
6	5	5. 34	5. 49	6. 4	6. 18	6. 33	6. 47	7. 2	6	6	
5	7	5. 44	5. 59	6. 14	6. 29	6. 44	6. 59	7. 14	8	4	
Novemb. 1	9	5. 53	6. 9	6. 24	6. 40	6. 55	7. 11	7. 26	10	2 May	
October 30	11	6. 3	6. 18	6. 34	6. 50	7. 6	7. 21	7. 37	12	30 April	
29	13	6. 12	6. 28	6. 44	7. 0	7. 16	7. 32	7. 48	14	29	
28	15	6. 20	6. 36	6. 53	7. 10	7. 26	7. 42	7. 58	16	28	
27	17	6. 29	6. 45	7. 2	7. 19	7. 36	7. 52	8. 9	18	27	
26	19	6. 39	6. 55	7. 13	7. 31	7. 48	8. 5	8. 22	21	26	
25	20	6. 48	7. 6	7. 24	7. 42	8. 0	8. 17	8. 34	24	25	
18	23	6. 48	7. 6	7. 24	7. 42	8. 0	8. 17	8. 34	24	18	
16	February 26	6. 57	7. 15	7. 34	7. 52	8. 10	8. 28	8. 46	27	16	
13	March 1	7. 6	7. 24	7. 43	8. 1	8. 20	8. 38	8. 57	30 August	12	
9	4	7. 12	7. 31	7. 50	8. 9	8. 28	8. 46	9. 6	2 Sept.	9	
6	7	7. 17	7. 36	7. 55	8. 14	8. 33	8. 53	9. 12	5	6	
October 8	10	7. 23	7. 42	8. 1	8. 20	8. 39	8. 59	9. 18	8	3 April	
Septemb. 30	13	7. 26	7. 45	8. 4	8. 24	8. 43	9. 3	9. 22	11	31 March	
27	16	7. 29	7. 48	8. 7	8. 27	8. 47	9. 6	9. 25	14	28	
24	19	7. 30	7. 50	8. 10	8. 29	8. 49	9. 8	9. 27	17	25	
After Equinox.	Before Equinox.	7. 31	7. 50	8. 10	8. 30	8. 50	9. 9	9. 28	Before Equinox.	After Equinox.	

TABLE V.

For reducing the Sun's DECLINATION as given in the Nautical Almanac for noon at Greenwich, to any other Time under any other Meridian.

Add alt. N. Sub. bef. N.	Sub. alt. N. Add. bef. N.	H. M. H. M.	H. M. H. M.	H. M. H. M.	H. M. H. M.	H. M. H. M.	H. M. H. M.	H. M. H. M.	Sub. alt. N. Add. bef. N.	Add alt. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	150 Deg.	155 Deg.	160 Deg.	165 Deg.	170 Deg.	175 Deg.	180 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0.11	0.11	0.12	0.12	0.12	0.13	0.13	22	20
19	23	0.22	0.22	0.24	0.24	0.25	0.26	0.26	23	19
18	24	0.33	0.34	0.36	0.36	0.37	0.38	0.39	24	18
17	25	0.44	0.46	0.47	0.48	0.50	0.51	0.53	25	17
16	26	0.55	0.57	0.58	1. 0	1. 2	1. 4	1. 6	26	16
15	27	1. 0	1. 8	1.11	1.13	1.15	1.17	1.19	27	15
14	28	1.17	1.20	1.23	1.25	1.27	1.30	1.32	28	14
13	29	1.28	1.31	1.34	1.37	1.40	1.43	1.45	29	13
12	30	1.39	1.42	1.45	1.49	1.52	1.55	1.59	30 June	12
11	Decemb. 31	1.50	1.54	1.57	2. 1	2. 5	2. 8	2.12	1 July	11
10	January 1	2. 1	2. 5	2. 9	2.13	2.17	2.21	2.25	2	10
9	2	2.12	2.16	2.20	2.25	2.30	2.34	2.38	3	9
8	3	2.23	2.27	2.32	2.37	2.42	2.47	2.51	4	8
7	4	2.34	2.39	2.44	2.49	2.54	2.59	3. 4	5	7
6	5	2.44	2.50	2.55	3. 0	3. 6	3.12	3.17	6	6
5	6	2.55	3. 1	3. 6	3.12	3.18	3.24	3.30	7	5
4	7	3. 5	3.11	3.17	3.23	3.29	3.36	3.42	8	4
3	8	3.15	3.21	3.28	3.34	3.41	3.48	3.54	9	3
2	9	3.25	3.32	3.38	3.45	3.52	3.59	4. 0	10	2
Decemb. 1	10	3.35	3.42	3.49	3.56	4. 4	4.11	4.18	11	1
Novemb. 30	11	3.45	3.52	3.59	4. 7	4.15	4.22	4.30	12	31 May
29	12	3.55	4. 3	4.10	4.18	4.26	4.34	4.42	13	30
28	13	4. 6	4.13	4.21	4.29	4.38	4.46	4.54	14	29
27	14	4.16	4.23	4.31	4.40	4.49	4.57	5. 5	15	28
26	15	4.24	4.33	4.41	4.50	4.59	5. 8	5.17	16	27
25	16	4.34	4.43	4.52	5. 1	5.10	5.19	5.28	17	26
24	17	4.43	4.53	5. 2	5.11	5.21	5.30	5.40	18	25
23	18	4.52	5. 2	5.12	5.22	5.32	5.41	5.51	19	24
22	19	5. 1	5.12	5.22	5.32	5.42	5.52	6. 2	20	23
21	20	5.10	5.21	5.31	5.42	5.53	6. 3	6.13	21	22
20	21	5.20	5.31	5.41	5.52	6. 2	6.13	6.24	22	21
19	22	5.29	5.40	5.51	6. 2	6.13	6.24	6.34	23	20
18	23	5.37	5.49	5. 0	6.11	6.23	6.34	6.44	24	19
17	24	5.45	5.57	5. 9	6.20	6.32	6.43	6.54	25	18
16	25	5.54	6. 6	6.17	6.29	6.41	6.53	7. 4	26	17
15	26	6. 2	6.14	6.26	6.38	6.51	7. 3	7.14	27	16
14	27	6.10	6.22	6.34	6.47	7. 0	7.12	7.24	28	15
13	28	6.19	6.31	6.43	6.56	7. 9	7.22	7.34	29	14
11	January 30	6.34	6.47	7. 0	7.13	7.26	7.40	7.53	31 July	13
9	February 1	6.49	7. 3	7.16	7.30	7.43	7.57	8.11	2 August	10
7	2	7. 3	7.17	7.31	7.45	7.59	8.13	8.27	4	8
5	3	7.16	7.31	7.45	8. 0	8.14	8.28	8.43	6	6
3	4	7.29	7.44	7.59	8.14	8.28	8.43	8.58	8	4
Novemb. 1	9	7.41	7.56	8.12	8.27	8.42	8.57	9.13	10	2 May
October 30	11	7.53	8. 8	8.24	8.40	8.56	9.12	9.28	12	30 April
28	13	8. 4	8.20	8.36	8.53	9. 9	9.25	9.42	14	28
26	15	8.15	8.32	8.48	9. 5	9.21	9.38	9.54	16	26
24	17	8.26	8.43	9. 0	9.17	9.34	9.50	10. 7	18	24
21	20	8.40	8.57	9.14	9.32	9.49	10. 6	10.24	21	21
19	23	8.52	9.10	9.28	9.46	10. 3	10.21	10.39	24	18
16	February 26	9. 4	9.22	9.40	9.58	10.16	10.34	10.53	27	15
13	March 1	9.15	9.33	9.51	10.10	10.29	10.47	11. 6	30 August	12
9	4	9.24	9.43	10. 1	10.20	10.39	10.58	11.16	2 Sept.	9
6	7	9.30	9.50	10. 9	10.28	10.47	11. 6	11.24	5	6
October 3	10	9.37	9.56	10.16	10.35	10.54	11.13	11.32	8	3 April
Septemb. 30	13	9.41	10. 0	10.21	10.40	10.59	11.18	11.38	11	31 March
27	16	9.45	10. 4	10.24	10.44	11. 3	11.22	11.42	14	28
24	19	9.47	10. 6	10.26	10.46	11. 5	11.24	11.44	17	25
After Equinox.	Before Equinox.	9.48	10. 7	10.27	10.47	11. 6	11.25	11.45	Before Equinox.	After Equinox.

TABLE VI.—SUN'S RIGHT ASCENSION.

77

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	
1	18.45	20.58	22.46	0.42	2.33	4.35	6.40	8.44	10.41	12.29	14.25	16.29	1
2	18.50	21.2	22.52	0.45	2.37	4.39	6.44	8.48	10.44	12.32	14.29	16.33	2
3	18.54	21.6	22.55	0.49	2.40	4.44	6.48	8.52	10.48	12.36	14.33	16.37	3
4	18.59	21.10	22.59	0.52	2.44	4.48	6.52	8.56	10.51	12.40	14.37	16.42	4
5	19.3	21.14	23.3	0.56	2.48	4.52	6.56	9.0	10.55	12.43	14.41	16.46	5
6	19.7	21.19	23.7	1.0	2.52	4.56	7.0	9.4	10.59	12.47	14.45	16.50	6
7	19.12	21.23	23.10	1.3	2.56	5.0	7.4	9.8	11.2	12.51	14.49	16.55	7
8	19.16	21.26	23.14	1.7	3.0	5.4	7.8	9.11	11.6	12.54	14.53	16.59	8
9	19.21	21.30	23.18	1.11	3.3	5.8	7.13	9.15	11.10	12.58	14.57	17.4	9
10	19.25	21.34	23.21	1.14	3.7	5.12	7.17	9.19	11.13	13.2	15.1	17.8	10
11	19.29	21.38	23.25	1.18	3.11	5.17	7.21	9.23	11.17	13.5	15.5	17.12	11
12	19.34	21.42	23.29	1.22	3.15	5.21	7.25	9.27	11.20	13.9	15.9	17.17	12
13	19.38	21.46	23.32	1.25	3.19	5.25	7.29	9.30	11.24	13.13	15.13	17.21	13
14	19.42	21.50	23.36	1.29	3.23	5.29	7.33	9.34	11.28	13.16	15.17	17.26	14
15	19.47	21.54	23.40	1.33	3.27	5.33	7.37	9.38	11.31	13.20	15.21	17.30	15
16	19.51	21.58	23.43	1.36	3.31	5.37	7.41	9.42	11.35	13.24	15.25	17.34	16
17	19.55	22.1	23.47	1.40	3.35	5.41	7.45	9.45	11.39	13.28	15.29	17.39	17
18	19.59	22.5	23.51	1.44	3.39	5.46	7.49	9.49	11.42	13.31	15.34	17.43	18
19	20.4	22.9	23.54	1.48	3.43	5.50	7.53	9.53	11.45	13.35	15.38	17.48	19
20	20.9	22.13	23.58	1.51	3.47	5.54	7.57	9.57	11.49	13.39	15.42	17.52	20
21	20.12	22.17	0.2	1.55	3.51	5.58	8.1	10.0	11.53	13.43	15.46	17.57	21
22	20.16	22.21	0.5	1.59	3.55	6.2	8.5	10.4	11.56	13.46	15.50	18.1	22
23	20.21	22.24	0.9	2.2	3.59	6.6	8.9	10.9	12.0	13.50	15.55	18.6	23
24	20.25	22.28	0.12	2.6	4.3	6.11	8.13	10.11	12.3	13.53	15.59	18.10	24
25	20.29	22.32	0.16	2.10	4.7	6.15	8.17	10.15	12.7	13.58	16.3	19.14	25
26	20.33	22.36	0.20	2.14	4.11	6.19	8.21	10.19	12.11	14.2	16.7	19.19	26
27	20.37	22.39	0.23	2.18	4.15	6.23	8.25	10.22	12.14	14.6	16.11	19.23	27
28	20.41	22.43	0.27	2.21	4.19	6.27	8.29	10.26	12.18	14.9	16.16	19.28	28
29	20.46	22.46	0.31	2.25	4.23	6.31	8.33	10.30	12.21	14.13	16.20	19.32	29
30	20.50		0.34	2.29	4.27	6.35	8.37	10.33	12.25	14.17	16.24	19.37	30
31	20.54		0.38	2.33	4.31		8.41	10.37		14.21		19.41	31

This Table gives nearly the mean of the Sun's Right Ascension for the years 1817, 1818, 1819, and 1820, and is nearly exact for finding when any Star comes to the meridian. But in all calculations for determining the time by celestial observations, the Sun's Right Ascension must be taken from the Nautical Almanac, where it is calculated to a greater degree of accuracy.

TABLE VI. A.

Correction for the daily variation of the Equation of Time found in Table IV. A.
Find the daily variation of Equation of Time at the top, the hour at Greenwich at the side.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30
0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	45
0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	60
0	0	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5	75
0	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	5	6	6	6	6	6	6	6	6	90
0	1	1	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	7	7	7	7	105
0	1	1	1	2	2	2	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	8	8	9	9	120
0	1	1	2	2	2	3	3	4	4	5	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	9	10	10	10	10	135
0	1	1	2	2	3	3	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	10	10	10	10	11	11	11	11	150
0	1	1	2	3	3	4	4	5	5	6	6	6	7	7	7	8	8	8	9	9	10	10	11	11	11	12	12	12	12	12	165
1	1	2	2	3	4	4	5	5	6	6	7	7	7	8	8	8	9	9	9	10	10	11	11	12	12	13	13	13	13	13	180
1	1	2	2	3	4	5	5	6	6	7	7	8	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14	14	14	14	195
1	1	2	2	3	4	5	6	6	7	7	8	8	8	9	9	10	10	11	11	12	12	13	13	14	15	15	15	16	16	16	210
1	1	2	3	3	4	5	6	6	7	8	8	8	9	9	10	10	11	11	12	12	13	13	14	15	15	16	16	17	17	17	225
1	1	2	3	3	4	5	6	7	7	8	9	9	10	10	11	11	12	12	13	13	14	15	15	16	16	17	17	18	18	18	240
1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	12	13	13	14	15	15	16	16	17	17	18	19	19	19	255
1	1	2	3	4	5	5	6	7	8	8	9	10	10	11	11	12	13	13	14	15	15	16	16	17	17	18	19	19	20	20	270
1	1	2	3	4	5	6	6	7	8	9	10	10	11	12	12	13	14	14	15	16	16	17	17	18	19	19	20	21	21	21	285
1	1	2	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	15	16	17	17	18	19	19	20	21	21	22	22	22	300
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14	15	16	16	17	18	18	19	20	20	21	22	22	23	23	23	315
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17	18	19	20	21	22	22	23	24	24	24	25	25	330
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23	24	25	25	26	26	26	345
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	27	27	27	360

TABLE VII.
AMPLITUDES.

DECLINATION IN DEGREES.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
[1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	F																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D

TABLE VIII.

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1920, with their annual variations.

<i>Names and situations of the STARS.</i>	<i>Character.</i>	<i>Magnitudes.</i>	<i>Right Ascension.</i>	<i>Ann. Var. R. A. addl after. 1920.</i>	<i>Declination.</i>	<i>Annual Variation.</i>
			H.M.S.	"	O.	"
Extremity of the wing of Pegasus, <i>Algenib</i>	γ	2	0. 3.59	8.08	14.11 N.	+20.1
In the head of the Phenix	"	2.3	0.17.22	2.99	43.16 S.	-20.0
Bright Star in the tail of the Whale	β	2.3	0.34.32	3.00	18.59 S.	-19.9
Polar Star, tail of the Little Bear	"	2.3	0.57. 1	14.28	88.21 N.	+19.4
In the girdle of Andromeda	β	2	0.59.40		34.40 N.	+19.5
The spring of the River Erida, <i>Achernar</i>	"	1	1.31. 0	2.25	58. 9 S.	-18.5
Almach in the foot of Andromeda	γ	2	1.52.58	3.62	41.28 N.	+17.7
*The following horn of the Ram, <i>ARJETIS</i>	"	2	1.57. 3	3.35	22.36 N.	+17.4
In the neck of the Whale	"	2	2.10.15	3.02	3.48 S.	-17.0
In the jaw of the Whale	"	2	2.52.52	3.12	3.23 N.	+14.8
In the head of Medusa, <i>Algol</i>	β	2	2.56.28	3.85	40.15 N.	+14.6
The bright Star in Perseus	"	2	3.11.31	4.20	49.13 N.	+12.6
The bright Star of the Pleiades, or Seven Stars	"	3	3.36.47	3.54	23.33 N.	+11.3
*The southern eye of the Bull, <i>ALDEBARAN</i>	"	1	4.25.38	3.48	16. 2 N.	+ 8.0
In the left shoulder of Auriga, <i>Capella</i>	"	1	5. 3.24	4.41	45.48 N.	+ 4.6
The bright foot of Orion, <i>Rigel</i>	β	1	5. 5.53	2.38	8.25 S.	- 4.9
The northern horn of the Bull	β	2	5.14.55	5.78	28.27 N.	+ 3.8
The western shoulder of Orion	γ	2	5.15.29	1.21	6.11 N.	+ 4.0
In the belt of Orion	δ	2	5.22.49	3.00	0.27 S.	- 2.3
	"	2	5.27. 4	3.03	1.19 S.	- 3.0
	ζ	2	5.31.41	3.02	2. 9 S.	- 2.0
Bright Star in the Dove	"	2	5.33. 9	2.17	31.10 S.	- 2.4
The eastern shoulder of Orion	"	1	5.45.28	1.25	7.22 N.	+ 1.4
In the foot of the Great Dog	β	2	6.14.46	2.64	17.52 S.	+ 1.8
In the poop of the ship Argo <i>Canopus</i>	"	1	6.19.57	1.33	52.36 S.	+ 1.7
In the ankle of Pollux	γ	2.3	6.27.19	1.46	16.38 N.	- 2.0
In the mouth of the Greater Dog, <i>Sirius</i>	"	1	6.37.13	2.64	16.29 S.	+ 4.4
In the thigh of the Greater Dog	"	2.3	6.51.00	2.35	23.44 S.	+ 4.4
In the back of the Greater Dog	δ	2.3	7. 1. 3	2.44	26. 7 S.	+ 5.2
In the tail of the Greater Dog	"	2	7.16.59	2.00	28.57 S.	+ 6.5
In the head of the northern Twin, <i>Castor</i>	"	1.2	7.23. 6	1.00	32.16 N.	- 7.1

TABLE VIII.

81

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1820, with their annual variations.

<i>Names & situations of the STARS.</i>	<i>Characters.</i>	<i>Magnitudes.</i>	<i>Right Ascension.</i>	<i>Ann. Par. R. A. add after 1820.</i>	<i>Declination.</i>	<i>Annual Variation.</i>
			H. M. S.	"	° ' "	"
The Lesser Dog <i>Procyon</i>	"	1.2	7.29.52	3.15	5.41 N.	— 3.5
* In the head of the southern Twin, <i>POLLUX</i>	β	1.2	7.34.17	3.60	23.27 N.	— 8.0
In the row lock of the ship Argo	ξ	2	7.57.16	2.12	39.30 S.	+ 9.7
In the poop of the ship Argo	γ	2	8. 4. 1	1.86	46.48 S.	+10.3
In the middle of the ship Argo	δ	2.3	8.39.45	1.68	54. 3 S.	+12.9
In the oars of the ship Argo	β	2.3	9.11.13	0.75	68.59 S.	+14.9
The heart of the female Hydra, <i>Alphard</i>	"	2	9.18.44	2.95	7.53 S.	+15.2
* The Lion's heart <i>REGULUS</i>	"	1.2	9.58.48	3.21	12.51 N.	—17.3
South pointer in the sq. of the Great Bear	β	2	10.50.54	3.71	57.21 N.	—19.1
North pointer in the sq. of the Great Bear	"	1.2	10.52.32	—	62.43 N.	—19.3
The Lion's tail— <i>Denebola</i>	β	1.2	11.39.52	3.07	15.35 N.	—20.0
S. E. Star of \square of the Great Bear	γ	2	11.44.19	3.20	54.42 N.	—20.0
N. E. Star of \square of the Great Bear	δ	3	12. 6.27	3.02	52. 2 N.	—20.1
In the foot of the Cross	"	1	12.16.41	3.24	64. 6 S.	+20.0
In the top of the Cross	γ	2	12.21.13	3.21	56. 6 S.	+20.0
In the following arm of the Cross	β	2	12 37.18	3.41	52.41 S.	+19.6
<i>Alkath</i> , first star in the tail of the Great Bear	"	2.3	12.46. 8	2.75	56.56 N.	—19.7
* The Virgin's spike— <i>SPICA</i>	"	1	13.15.43	3.14	10.13 S.	+19.0
The second Star in the tail of the Great Bear	ζ	2.3	13.16.39	2.43	55.52 N.	—19.0
Last Star in the tail of the Great Bear	η	2	13.40.26	2.38	50.13 N.	—18.2
The western foot of the Centaur	β	2	13.51.14	4.10	59.30 S.	+17.3
In the tail of the Dragon	"	2.3	13.59.31	1.63	63.14 N.	—17.4
The bright Star in Bootes— <i>Arcturus</i>	"	1	14. 7.26	2.73	20. 8 N.	—19.0
The eastern foot of the Centaur	"	1	14.28. 0	4.44	80. 7 S.	—16.1
The southern scale of the Balance	"	2.3	14.40.56	3.29	15.17 S.	+15.2
The northern scale of the Balance	β	2.3	15. 7.20	3.22	8.43 S.	+13.3
Bright Star in the crown <i>Gemma</i>	"	2	15.27. 4	2.53	27.20 N.	—12.5

TABLE VIII.

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1820, with their annual variations.

Names & situations of the STARS.	Obliquity.	Magnitudes.	Right Ascension.	Ann. Var. R. A. add. after 1820.	Declination.	Annual Variation.
			H. M. S.	"	° ' "	"
In the neck of the Serpent	*	2	15.35.24	2.94	7. 0 N.	—11.7
The northernmost Star of the Scorpion's forehead	β	2	15.55. 0	3.47	19.18 S.	+10.5
* The Scorpion's heart, <i>ANTARES</i>	α	1	16.18.28	3.66	26. 1 S.	+ 8.6
In the eastern knee of Ophiuchus	γ	2.5	17. 0. 3	3.42	15.30 S.	+ 5.3
In the head of Hercules	α	2	17. 6.27	2.78	14.36 N.	— 4.5
In the head of Ophiuchus	α	2	17.26.35	2.77	12.42 N.	— 3.1
In the head of the Dragon	γ	2.3	17.52.25	1.38	51.31 N.	— 0.7
In the bow of Sagittarius	ε	2.3	18.12.14	3.98	34.28 S.	— 0.8
The bright Star in the Harp, <i>Wega</i> , <i>LYRA</i>	α	1	18.30.51	2.03	38.37 N.	+ 3.0
* Bright Star in the Eagle, <i>Atair</i> , <i>AQUILA</i>	α	1	19.42. 0	2.93	8.24 N.	+ 9.1
The eye of the Peacock	α	2	20.11.20	4.85	57.18 S.	—10.8
The tail of the Swan <i>Deneb</i>	α	1.2	20.35.18	2.04	44.39 N.	+12.6
The western wing of the Crane	α	2	21.56.49	5.85	47.49 S.	—17.4
* In the mouth of the southern fish, <i>FOMALHAUT</i>	α	1	22.47.41	3.34	30.34 S.	—13.1
In the shoulder of Pegasus	β	2	22.55. 3	2.87	27. 7 N.	+19.2
* In the wing of Pegasus, <i>Markab</i> , <i>PEGASUS</i>	α	2	22.55.48	2.98	14.14 N.	+19.4
In the head of Andromeda	α	2	23.59. 6	3.03	28. 6 N.	+20.0
Near the shoulder of Cassiopea	β	2.3	23.59.35	3.05	58. 9 N.	+20.1

NOTE.—If the places of these stars are wanted for any time before the beginning of the year 1820, multiply the annual variation, in right ascension, by the number of years before 1820, and subtract the product from the right ascension standing in the table; but the product of the annual variation in declination by the number of years before 1820 must be added to, or subtracted from the declination, according as the sign — or + is marked in the Table; but for any years after 1820, the annual variation in right ascension multiplied by the number of years after 1820 must be added to the right ascension in the Table, and the annual variation in declination multiplied by the number of years after 1820 must be either added to, or subtracted from the declination, according to the signs in the Table.—The annual variation is set down for seconds and decimals of a second. An asterisk is prefixed to the stars whose distances from the moon are given in the Nautical Almanac. When very great accuracy is required, the corrections found in Tables XLII. and XLIII. for aberration and nutation, are to be applied to the numbers deduced from Table VIII. but these corrections are generally not of much importance in nautical calculations. The corrected values are however given in the Nautical Almanac for 21 of the bright stars of this catalogue for every ten days in the year, and these values are always to be preferred.

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

[illegible]

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

[illegible]

TABLE X.

85

For finding the Distance of Terrestrial Objects at Sea, in Statute miles.

Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. M. Tenths.
1	1.32	44	8.78	320	23.67	1000	41.8
2	1.87	45	8.87	330	24.03	1100	43.1
3	2.29	46	8.97	340	24.39	1200	43.8
4	2.65	47	9.07	350	24.76	1300	44.7
5	2.96	48	9.17	360	25.10	1400	45.5
6	3.24	49	9.26	370	25.45	1500	46.2
7	3.50	50	9.35	380	25.79	1600	46.9
8	3.74	55	9.81	390	26.13	1700	47.5
9	3.97	60	10.25	400	26.47	1800	48.1
10	4.18	65	10.67	410	26.79	1900	48.7
11	4.39	70	11.07	420	27.11	2000	49.2
12	4.58	75	11.46	430	27.43	2100	50.6
13	4.77	80	11.83	440	27.75	2200	52.1
14	4.95	85	12.20	450	28.06	2300	53.4
15	5.12	90	12.55	460	28.37	2400	54.8
16	5.29	95	12.89	470	28.68	2500	56.1
17	5.45	100	13.23	480	28.98	2600	57.5
18	5.61	105	13.56	490	29.29	2700	58.7
19	5.77	110	13.88	500	29.58	2800	59.0
20	5.92	115	14.19	550	30.17	2900	61.2
21	6.06	120	14.49	600	30.74	3000	62.5
22	6.21	125	14.79	650	31.31	3100	63.7
23	6.34	130	15.08	700	31.86	3200	64.8
24	6.48	135	15.37	750	32.41	3300	65.0
25	6.61	140	15.65	800	32.94	3400	67.1
26	6.75	145	15.93	850	33.47	3500	68.3
27	6.87	150	16.20	900	33.99	3600	69.4
28	7.00	160	16.73	950	34.50	3700	70.5
29	7.12	170	17.25	1000	35.00	3800	71.6
30	7.25	180	17.75	1050	35.50	3900	72.6
31	7.37	190	18.24	1100	35.99	4000	73.7
32	7.49	200	18.71	1150	36.47	4100	74.7
33	7.60	210	19.17	1200	36.95	4200	75.7
34	7.71	220	19.62	1250	37.42	4300	76.8
35	7.83	230	20.06	1300	37.88	4400	77.8
36	7.94	240	20.50	1350	38.34	4500	78.7
37	8.05	250	20.92	1400	38.80	4600	79.7
38	8.16	260	21.33	1450	39.25	4700	80.7
39	8.26	270	21.74	1500	39.69	4800	81.7
40	8.37	280	22.14	1550	40.13	4900	82.6
41	8.47	290	22.53	1600	40.56	5000	83.5
42	8.57	300	22.91	1650	40.99	1 mile.	84.5
43	8.68	310	23.29	1700	41.42		85.1

TABLE XI.

Seek the nearest number to the reduced time in the top column, and the difference of paral-
 lax, proportional logarithm, or semi-diameter for 12 hours in the side column; under the
 former and opposite the latter, is the correction to be applied to the number, marked first
 in the Nautical Almanac, additive if increasing, subtractive if decreasing.

Var. in 12 hrs.	REDUCED TIME.																							
	0	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12
	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h
12	12	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½	22	22½	23	23½	24
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
3	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
4	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
5	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5
6	0	0	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	6	6	6
7	0	1	1	1	2	2	2	3	3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7
8	0	1	1	1	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	7	7	8	8	8
9	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	8	8	9	9	9
10	0	1	1	2	2	2	3	3	4	4	5	5	5	6	6	7	7	7	8	8	9	10	10	10
11	0	1	1	2	2	3	3	4	4	5	5	5	6	6	7	7	8	8	9	9	10	10	11	11
12	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12
13	1	1	2	2	3	3	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13
14	1	1	2	2	3	3	4	5	5	6	6	7	8	8	9	9	10	10	11	12	12	13	13	14
15	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	11	11	12	12	13	14	14	15
16	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16
17	1	1	2	3	4	4	5	6	6	7	8	8	9	10	11	11	12	13	13	14	15	16	16	17
18	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	13	13	14	15	16	16	17	18
19	1	2	2	3	4	5	6	6	7	8	9	9	10	11	12	13	13	14	15	16	17	17	18	19
20	1	2	2	3	4	5	6	7	7	8	9	10	11	12	12	13	14	15	16	17	17	18	19	20
21	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	17	18	19	20	21
22	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22
23	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23
24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
25	1	2	3	4	5	7	7	8	9	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25
26	1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	21	22	23	24	25	26
27	1	2	3	4	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22	23	25	26	27
28	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24	26	27	28
29	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23	24	25	27	28	29
30	1	2	4	5	6	7	9	10	11	12	14	15	16	17	19	20	21	22	24	25	26	28	29	30
31	1	3	4	5	6	8	9	10	12	13	14	15	17	18	19	21	22	23	25	26	27	28	30	31
32	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32
33	1	3	4	5	7	8	10	11	12	14	15	16	18	19	21	22	23	25	26	27	29	30	32	33
34	1	3	4	6	7	8	10	11	13	14	16	17	18	20	21	23	24	25	27	28	30	31	33	34
35	1	3	4	6	7	9	10	12	13	15	16	17	19	20	22	23	25	26	28	29	31	32	34	35
36	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30	31	33	34	36
37	2	3	5	6	8	9	11	12	14	15	17	18	20	22	23	25	26	28	29	31	32	34	35	37
38	2	3	5	6	8	9	11	13	14	16	17	19	21	22	24	25	27	28	30	32	33	35	36	38
39	2	3	5	6	8	10	11	13	16	16	18	19	21	23	24	26	28	29	31	32	34	36	37	39
40	2	3	5	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33	35	37	38	40
41	2	3	5	7	9	10	12	14	15	17	19	20	22	24	26	27	29	31	32	34	36	38	39	41
42	2	3	5	7	9	10	12	14	16	17	19	21	23	24	26	28	30	31	33	35	37	38	40	42
43	2	4	5	7	9	11	13	14	16	18	20	21	23	25	27	28	30	32	34	36	38	39	41	43
44	2	4	5	7	9	11	13	15	16	18	20	22	24	26	27	29	31	33	35	37	38	40	42	44
45	2	4	6	7	9	11	13	15	17	19	21	22	24	26	28	30	32	34	36	37	39	41	43	45

TABLES XII, XIII, XIV, XV, AND XVI.

87

TABLE XII. The Refraction of the Earth's Surface in Altitude.

	APP Alt	Ref	APP Alt	Ref
	D M S		D M S	
0	6 30 7	52	30	1.38
11	6 40 7	41	31	1.35
22	6 50 7	31	32	1.31
36	7 07 21		33	1.28
50	7 10 7	12	34	1.24
6	7 20 7	3	35	1.21
23	7 30 6	54	36	1.18
41	7 40 6	46	37	1.16
0	7 50 6	38	38	1.13
20	8 06 30		39	1.10
42	8 10 6	22	40	1.8
5	8 20 6	15	41	1.5
29	8 30 6	8	42	1.3
	8 40 6	1	43	1.1
50	8 50 5	65	44	0.59
47	9 05 49		45	0.57
15	9 10 5	43	46	0.53
44	9 20 5	37	47	0.53
15	9 30 5	31	48	0.51
46	9 40 5	26	49	0.50
18	9 50 5	20	50	0.48
51	10 05 15		51	0.46
25	10 15 5	8	52	0.45
59	10 30 5	0	53	0.43
35	10 45 4	54	54	0.41
11	11 04 47		55	0.40
48	11 15 4	41	56	0.38
26	11 30 4	35	57	0.37
4	11 45 4	29	58	0.35
44	12 04 29		59	0.34
33	12 20 4	16	60	0.33
4	12 40 4	9	61	0.32
45	13 04 3		62	0.30
27	13 20 3	57	63	0.29
9	13 40 3	51	64	0.28
52	14 03 46		65	0.27
85	14 20 3	40	66	0.25
19	14 40 3	35	67	0.24
3	15 03 30		68	0.23
	15 30 3	23	69	0.22
33	16 03 17		70	0.21
19	16 30 3	11	71	0.20
5	17 03 5		72	0.19
39	17 30 2	59	73	0.17
14	18 02 54		74	0.16
50	18 30 2	49	75	0.15
28	19 02 44		76	0.14
7	19 30 2	40	77	0.13
47	20 02 36		78	0.12
28	20 30 2	32	79	0.11
10	21 02 28		80	0.10
53	21 30 2	24	81	0.9
37	22 02 20		82	0.8
31	23 02 14		83	0.7
7	24 02 7		84	0.6
53	25 02 2		85	0.5
39	26 01 56		86	0.4
27	27 01 51		87	0.3
16	28 01 47		88	0.2
3	29 01 43		89	0.1

TABLE XIII. Depression or Dip of the Horizon of the sea.

Height of the eye.	Dip of the Horizon
M.	S.
1	0.59
2	1.24
3	1.42
4	1.58
5	2.12
6	2.25
7	2.36
8	2.47
9	2.57
10	3.7
11	3.16
12	3.25
13	3.34
14	3.41
15	3.49
16	3.56
17	4.3
18	4.11
19	4.17
20	4.24
21	4.31
22	4.37
23	4.43
24	4.49
25	4.55
26	5.1
28	5.13
30	5.19
35	5.49
40	6.14
45	6.36
50	6.58
60	7.37
70	8.14
80	8.48
90	9.20
100	9.51

TABLE XIV. The Sun's Parallax in Altitude.

Sun's Alt.	Sun's Parallax
D	S
0	9
10	9
20	8
30	8
40	7
50	6
60	5
70	4
80	3
90	2
100	1
110	0

TABLE XV. Augmentation of the Moon's Semi-diameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	5
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80	15
90	16

TABLE XVI. Dip of the Sea at different Distances from the Observer.

Dist. of the land in Sea miles.	Height of the Eye above the Sea in Feet.							
	5	10	15	20	25	30	35	40
	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.
	M.	M.	M.	M.	M.	M.	M.	M.
1	11	23	34	45	57	68	79	91
2	6	12	17	23	28	34	40	45
3	4	8	11	15	19	23	27	30
4	3	6	9	12	15	17	20	23
5	3	5	7	10	12	14	16	19
6	3	4	6	8	10	12	14	16
7	2	4	5	7	8	9	11	12
8	2	3	4	6	7	8	10	10
9	2	3	4	5	6	7	8	9
10	2	3	4	5	6	6	8	8
11	2	3	4	5	5	6	7	7
12	2	3	4	5	5	6	6	7
13	2	3	4	4	5	5	6	6
14	2	3	4	4	5	5	6	6
15	2	3	4	4	5	5	6	6

TABLE XVI.—The numbers of this table below the black lines, are the same as given in Table XIII the visible horizon, corresponding to those heights, and so far distant as the land.

TABLE XVII.

WHEN A STAR IS USED.

*Ap AR	Cor	Log	*Ap AR	Cor	Log	*Ap AR	Cor	Log	*Ap AR	Cor	Log	*Ap AR	Cor	Log
D M S			D M S			D M S			D M S			D M S		
8. 0	50 240	9700	10. 0	54 45	2277	13. 15	56 2	3433	16. 0	57 16	4723	36. 30	58 45	7517
10	50 240	9700		54 47	2277	20 56	3	3456	10 57	17	4968	37	0 58 45	7558
20	50 340	9817		54 48	2317	25 56	5	3483	20 57	19	4985	30 58	47	7618
30	50 540	9930		54 50	2337	30 56	6	3511	30 57	20	5031	38	0 58 47	7658
40	51 2	10041		54 51	2357	35 56	8	3537	40 57	22	5065	40 58	48	7717
50	51 21	10150		54 53	2377	40 56	9	3562	50 57	23	5101	50	0 58 50	7766
8. 0	51 34	10253	10. 10	54 54	2397	13. 45	56 10	3587	20. 0	57 25	5176	39 30	58 51	7810
10	51 36	10360		54 56	2417	20 56	12	3612	10 57	26	5170	40	0 58 52	7854
20	51 57	10462		54 57	2437	25 56	13	3637	20 57	27	5204	30 59	53	7900
30	52 9	10562		54 58	2457	14. 0	56 15	3662	30 57	29	5238	41	0 58 55	7946
40	52 13	10660		54 59	2476	5 56	16	3687	40 57	30	5271	30 58	54	7987
50	52 20	10755		54 59	2496	10 56	17	3711	50 57	31	5304	42	0 58 57	8028
7. 0	52 30	10849	10. 30	55 3	2515	14. 15	56 19	3735	21. 0	57 33	5338	43 30	58 54	8070
10	52 40	10941		55 5	2534	20 56	20	3759	10 57	34	5370	43	0 58 54	8112
20	52 58	11032		55 6	2553	25 56	21	3783	20 57	35	5401	30 59	0	8152
30	53 6	11120		55 6	2572	30 56	22	3807	30 57	36	5436	44	0 59 1	8198
35	53 11	11164		55 6	2591	35 56	24	3831	40 57	37	5468	30 59	2	8239
40	53 15	11207		55 6	2610	40 56	25	3856	50 57	39	5504	45	0 59 3	8280
7. 45	53 19	11250	10. 54	55 11	2629	14. 45	56 26	3878	22. 0	57 40	5539	46	59	8320
48	53 21	11753		55 12	2649	50 56	28	3901	10 57	41	5570	47	59	8361
51	53 24	11301		55 13	2667	55 56	29	3924	20 57	42	5606	48	59	8402
54	53 26	11326		55 14	2686	15. 0	56 30	3947	30 57	43	5641	49	59 11	8447
57	53 28	11351		55 14	2705	50 56	31	3970	40 57	44	5676	50	59 13	8481
8. 0	53 30	11376		55 15	2724	10 56	32	3993	50 57	45	5709	51	59 14	8526
8. 3	53 33	11401	11. 12	55 19	2742	15. 15	56 33	4016	23. 0	57 46	5740	52	59 16	8574
6	53 35	11425		55 19	2760	20 56	34	4039	10 57	47	5775	53	59 17	8614
9	53 37	11450		55 21	2778	25 56	35	4061	20 57	48	5809	54	59 19	8666
12	53 39	11474		55 22	2796	30 56	37	4083	30 57	49	5848	55	59 21	8700
15	53 42	11499		55 23	2814	35 56	38	4106	40 57	51	5882	56	59 23	8756
18	53 44	11523		55 24	2832	40 56	39	4127	50 57	52	5919	57	59 24	8803
8. 21	53 46	11547	11. 30	55 25	2850	15. 45	56 40	4149	24. 0	57 53	5959	58	59 24	8840
24	53 48	11571		55 27	2868	50 56	41	4171	10 57	54	5997	59	59 25	8879
27	53 50	11595		55 28	2886	55 56	42	4193	20 57	55	6035	60	59 27	8912
30	53 52	11619		55 29	2904	16. 0	56 43	4214	30 57	56	6073	61	59 28	8953
33	53 54	11642		55 30	2922	50 56	44	4236	40 57	57	6111	62	59 30	8986
36	53 56	11665		55 31	2940	10 56	45	4258	50 57	58	6149	63	59 31	9028
8. 30	53 58	11689	11. 48	55 32	2957	16. 15	56 46	4279	25. 0	57 56	6184	64	59 32	9068
42	54 0	11712		55 34	2974	20 56	47	4300	30 58	0	6217	65	59 34	9103
45	54 2	11735		55 35	2991	25 56	48	4321	40 58	1	6249	66	59 35	9139
48	54 4	11759		55 36	3008	30 56	49	4342	50 58	2	6281	67	59 36	9174
51	54 6	11781		55 37	3025	35 56	50	4363	60 58	3	6313	68	59 37	9206
54	54 08	11804		55 38	3042	40 56	51	4384	70 58	4	6345	69	59 38	9241
8. 37	54 10	11828	12. 6	55 39	3059	16. 45	56 52	4405	27. 0	58 9	6380	70	59 39	9281
9. 0	54 12	11849		55 40	3076	50 56	53	4425	30 58	10	6410	71	59 40	9322
3	54 13	11871		55 41	3093	55 56	54	4446	40 58	12	6449	72	59 42	9353
6	54 15	11893		55 42	3110	17. 0	56 56	4465	50 58	13	6488	73	59 43	9387
9	54 17	11916		55 43	3127	50 56	56	4485	60 58	15	6525	74	59 44	9420
12	54 19	11938		55 44	3144	10 56	57	4506	70 58	16	6561	75	59 45	9452
9. 15	54 21	11960	12. 24	55 45	3161	17. 15	56 58	4526	29. 0	58 18	6603	76	59 46	9483
18	54 22	11982		55 46	3178	30 56	59	4546	30 58	20	6702	77	59 47	9518
21	54 24	12003		55 47	3194	25 57	0	4568	40 58	22	6749	78	59 48	9552
24	54 26	12025		55 48	3211	30 57	1	4589	50 58	24	6783	79	59 49	9586
27	54 28	12047		55 49	3227	35 57	2	4609	60 58	25	6816	80	59 50	9620
30	54 29	12068		55 50	3243	40 57	3	4626	70 58	27	6857	81	59 51	9654
9. 33	54 31	12089	12. 42	55 51	3259	17. 45	57	4646	32. 0	58 29	7018	82	59 52	9688
36	54 33	12110		55 52	3275	30 57	4	4665	30 58	31	7074	83	59 53	9720
39	54 34	12132		55 53	3291	35 57	5	4684	40 58	33	7110	84	59 54	9754
42	54 36	12153		55 54	3307	18. 0	57	4703	50 58	34	7146	85	59 55	9787
45	54 37	12175		55 55	3323	10 57	8	4741	60 58	36	7182	86	59 56	9820
48	54 39	12194		55 56	3339	20 57	9	4778	70 58	37	7312	87	59 57	9851
9. 51	54 41	12215	13. 0	55 57	3355	13. 15	57	4815	33. 0	58 39	7353	88	59 58	9882
54	54 42	12236		55 58	3371	40 57	13	4832	30 58	40	7414	89	59 59	9912
57	54 44	12257		55 59	3387	50 57	14	4859	40 58	42	7466	90	60 0	9942

TABLE XVIII.

89

WHEN THE SUN IS USED.

Ap. Alt.	Cor.	Log	Ap. Alt.	Cor.	Log	Ap. Alt.	Cor.	Log	Ap. Alt.	Cor.	Log	Ap. Alt.	Cor.	Log	Ap. Alt.	Cor.	Log
D M M S			D M M S			D M M S			D M M S			D M M S			D M M S		
5.0	30.16	0.812	10.0	0.34	2.418	15.0	15.06	10.3292	19.0	0.57	2.418	20.0	30.38	50.17934			
10	50.32	0.9766		0.69	2.118		20.36	12.13619		10.57	25.1117		37.0	50.51	1.7900		
20	70.48	0.8259		1.31	1.2189		25.36	13.13616		20.57	27.1522		30.58	53.18045			
30	51.31	0.0009		1.53	1.2460		30.56	13.13672		30.57	29.15262		38.0	50.54	1.8100		
40	51.16	1.0113		1.25	0.12481		35.56	16.13099		40.57	30.15291		30.58	55.18154			
50	51.00	1.0223		15.55	1.12401		40.56	17.13725		50.57	31.15326		30.58	57.18206			
6.0	51.12	1.0329	10.1	15.55	3.12522	15.4	50.56	19.13777	20.0	0.57	33.15372	30.30	58.51	1.827			
10	51.50	1.0411		21.55	4.12544		50.56	20.13777		10.57	34.15406	40.0	0.58	59.1837			
20	52.61	0.0311		21.55	6.12599		50.56	22.13803		20.57	35.15444		50.59	0.18527			
30	52.17	1.0313		27.55	7.12583	14.0	0.56	23.13823		30.57	37.15430	41.0	0.58	1.18408			
40	52.25	1.0713		30.55	7.12603		5.56	24.13823		40.57	38.15513		30.59	2.18354			
50	52.38	1.0820		30.55	10.12623		10.56	25.1378		50.57	39.15590	42.0	0.59	3.18300			
7.0	52.41	1.0924	10.1	30.55	11.12643	15.1	15.56	27.13804	21.0	0.57	41.15522	12.30	59.51	4.18346			
10	52.51	1.1024		30.55	13.12683		20.56	27.13829		10.57	42.15619	43.0	0.59	5.18300			
20	53.61	1.1124		12.55	13.12683		25.56	29.13854		20.57	43.15633		30.59	6.18236			
30	53.15	1.121		14.55	15.12712		40.56	31.13979		30.57	44.15648	44.0	0.59	7.18203			
40	53.15	1.121		14.55	17.12722		45.56	32.14001		40.57	45.15719		30.59	8.18177			
50	53.25	1.1291		14.55	17.12722		50.56	33.14029		50.57	47.15732	45.0	0.59	9.18176			
7.45	53.51	1.134	10.1	14.55	19.12751	15.1	15.56	35.14023	22.0	0.57	49.15747	12.30	59.51	10.18136			
48	53.51	1.134		14.55	20.12751		40.56	36.14077		10.57	49.15747	47.0	0.59	11.18127			
51	53.51	1.134	11.0	14.55	21.12751		45.56	37.14101		20.57	50.15747	48.0	0.59	12.18127			
54	53.51	1.134		14.55	22.12751	15.0	0.56	38.14127		30.57	51.15747	49.0	0.59	13.18127			
57	53.51	1.134		14.55	23.12751		50.56	39.14127		40.57	52.15747	50.0	0.59	14.18127			
8.0	53.51	1.134		14.55	24.12751		10.56	40.14127		50.57	53.15747	51.0	0.59	15.18127			
8.3	53.51	1.134	11.1	14.55	25.12751	15.1	15.56	42.14127	23.0	0.57	54.15747	12.30	59.51	16.18127			
6	53.51	1.134		14.55	26.12751		20.56	43.14127		10.57	55.15747	53.0	0.59	17.18127			
9	53.51	1.134		14.55	27.12751		25.56	44.14127		20.57	56.15747	54.0	0.59	18.18127			
12	53.51	1.134		14.55	28.12751		30.56	45.14127		30.57	57.15747	55.0	0.59	19.18127			
15	53.51	1.134		14.55	29.12751		35.56	46.14127		40.57	58.15747	56.0	0.59	20.18127			
18	53.51	1.134		14.55	30.12751		40.56	47.14127		50.57	59.15747	57.0	0.59	21.18127			
8.21	53.51	1.134	11.1	14.55	31.12751	15.1	15.56	48.14127	24.0	0.57	60.15747	12.30	59.51	22.18127			
24	53.51	1.134		14.55	32.12751		40.56	49.14127		10.57	61.15747	58.0	0.59	23.18127			
27	53.51	1.134		14.55	33.12751		45.56	50.14127		20.57	62.15747	59.0	0.59	24.18127			
30	53.51	1.134		14.55	34.12751		50.56	51.14127		30.57	63.15747	60.0	0.59	25.18127			
33	53.51	1.134		14.55	35.12751		55.56	52.14127		40.57	64.15747	61.0	0.59	26.18127			
36	53.51	1.134		14.55	36.12751		10.56	53.14127		50.57	65.15747	62.0	0.59	27.18127			
8.39	53.51	1.134	11.1	14.55	37.12751	15.1	15.56	54.14127	25.0	0.57	66.15747	12.30	59.51	28.18127			
42	53.51	1.134		14.55	38.12751		20.56	55.14127		10.57	67.15747	59.0	0.59	29.18127			
45	53.51	1.134		14.55	39.12751		25.56	56.14127		20.57	68.15747	60.0	0.59	30.18127			
48	53.51	1.134		14.55	40.12751		30.56	57.14127		30.57	69.15747	61.0	0.59	31.18127			
51	53.51	1.134		14.55	41.12751		35.56	58.14127		40.57	70.15747	62.0	0.59	32.18127			
54	53.51	1.134		14.55	42.12751		40.56	59.14127		50.57	71.15747	63.0	0.59	33.18127			
8.57	53.51	1.134	11.1	14.55	43.12751	15.1	15.56	60.14127	26.0	0.57	72.15747	12.30	59.51	34.18127			
9.0	53.51	1.134		14.55	44.12751		40.56	61.14127		10.57	73.15747	59.0	0.59	35.18127			
3	53.51	1.134		14.55	45.12751		45.56	62.14127		20.57	74.15747	60.0	0.59	36.18127			
6	53.51	1.134		14.55	46.12751		50.56	63.14127		30.57	75.15747	61.0	0.59	37.18127			
9	53.51	1.134		14.55	47.12751		55.56	64.14127		40.57	76.15747	62.0	0.59	38.18127			
12	53.51	1.134		14.55	48.12751		10.56	65.14127		50.57	77.15747	63.0	0.59	39.18127			
9.15	53.51	1.134	12.1	14.55	49.12751	15.1	15.56	66.14127	27.0	0.57	78.15747	12.30	59.51	40.18127			
18	53.51	1.134		14.55	50.12751		20.56	67.14127		10.57	79.15747	59.0	0.59	41.18127			
21	53.51	1.134		14.55	51.12751		25.56	68.14127		20.57	80.15747	60.0	0.59	42.18127			
24	53.51	1.134		14.55	52.12751		30.56	69.14127		30.57	81.15747	61.0	0.59	43.18127			
27	53.51	1.134		14.55	53.12751		35.56	70.14127		40.57	82.15747	62.0	0.59	44.18127			
30	53.51	1.134		14.55	54.12751		40.56	71.14127		50.57	83.15747	63.0	0.59	45.18127			
9.33	53.51	1.134	12.1	14.55	55.12751	15.1	15.56	72.14127	28.0	0.57	84.15747	12.30	59.51	46.18127			
36	53.51	1.134		14.55	56.12751		45.56	73.14127		10.57	85.15747	59.0	0.59	47.18127			
39	53.51	1.134		14.55	57.12751		50.56	74.14127		20.57	86.15747	60.0	0.59	48.18127			
42	53.51	1.134		14.55	58.12751		55.56	75.14127		30.57	87.15747	61.0	0.59	49.18127			
45	53.51	1.134		14.55	59.12751		10.56	76.14127		40.57	88.15747	62.0	0.59	50.18127			
48	53.51	1.134		14.55	60.12751		15.56	77.14127		50.57	89.15747	63.0	0.59	51.18127			
9.51	53.51	1.134	13.1	14.55	61.12751	15.1	15.56	78.14127	29.0	0.57	90.15747	12.30	59.51	52.18127			
51	53.51	1.134		14.55	62.12751		20.56	79.14127		10.57	91.15747	59.0	0.59	53.18127			
54	53.51	1.134		14.55	63.12751		25.56	80.14127		20.57	92.15747	60.0	0.59	54.18127			

TABLE XIX.
CONNECTION.

TABLE A.											TABLE B.																
Prop part for Seconds of Paral.											Form of Alt.																
Add											Add																
Alt.	0	1	2	3	4	5	6	7	8	9	Alt.	0	1	2	3	4	5	6	7	8	9						
5	14	35	13	35	12	35	11	36	10	36	9	36	8	36	7	37	0	59	58	57	56	55	54	53	52	51	50
10	14	20	13	20	12	20	11	20	10	21	9	21	8	21	7	21	10	49	48	47	46	45	44	43	42	41	40
20	14	5	11	5	12	6	11	6	10	6	9	6	8	7	7	7	20	39	38	37	36	35	34	33	32	31	30
30	13	51	12	52	11	52	10	52	9	52	8	53	7	53	6	53	30	29	28	27	26	25	24	23	22	21	20
40	13	31	12	31	11	31	10	31	9	31	8	32	7	32	6	32	40	39	38	37	36	35	34	33	32	31	30
50	13	26	12	26	11	27	10	27	9	27	8	27	7	28	6	28	50	49	48	47	46	45	44	43	42	41	40
6	0	13	17	12	15	11	13	10	15	9	14	8	14	7	14	6	0	59	58	57	56	55	54	53	52	51	50
10	13	6	12	7	11	7	10	7	9	8	7	8	6	8	5	8	10	19	18	17	16	15	14	13	12	11	10
20	12	5	11	5	10	5	9	5	8	7	6	7	5	7	4	7	20	19	18	17	16	15	14	13	12	11	10
30	12	4	11	4	10	4	9	4	8	7	6	7	5	7	4	7	30	29	28	27	26	25	24	23	22	21	20
40	12	3	11	3	10	3	9	3	8	7	6	7	5	7	4	7	40	39	38	37	36	35	34	33	32	31	30
50	12	2	11	2	10	2	9	2	8	7	6	7	5	7	4	7	50	49	48	47	46	45	44	43	42	41	40
60	12	1	11	1	10	1	9	1	8	7	6	7	5	7	4	7	60	59	58	57	56	55	54	53	52	51	50

TABLE XIX.

CORRECTION.

App. alt. of \odot & con.	\odot 's Horizontal Parallax										TABLE A. Proportional part for Seconds of Parallax Add										TABLE B. For \odot 's alt. Add.	
	54'	55'	56'	57'	58'	59'	60'	61'			5	6	7	8	9	10	11	12	13	14	M	S
730	11 58	10 58	9 59	8 59	8 07	0	1 5	1			0 59	58	57	56	55	54	53	52	51	50		
40	11 50	10 51	9 51	8 52	7 53	5	54	54			10 49	48	47	46	45	44	43	42	41	40		
50	11 44	10 44	9 45	8 47	7 48	16	47	47			20 39	38	37	36	35	34	33	32	31	30		
8	0 11	37 10	38	9 38	39 7	10 6	40	41			30 29	28	27	26	25	24	23	22	21	20		
10	11 31	10 32	9 32	8 33	7 34	35	35	35			40 19	18	17	16	15	14	13	12	11	10		
20	11 25	10 26	9 26	8 27	7 28	29	29	29			50 9	8	7	6	5	4	3	2	1	0		

TABLE XIX. LOGARITHMS.

\odot 's Hor. Parallax	Apparent Altitude of \odot 's centre															TABLE C. Cor. for Seconds of Parallax. Add	
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	S	Cor.
M. S.	7	39	7	42	7	45	7	48	7	51	7	54	7	57	8	38	13
54	0	2791	2787	2783	2780	2777	2774	2770	2766	2763	2759	2756	2753			0	13
10	2776	2772	2768	2765	2762	2759	2756	2753	2749	2746	2743	2740	2738			1	12
20	2761	2757	2753	2750	2747	2743	2740	2736	2733	2730	2726	2723	2720			2	10
30	2745	2741	2737	2734	2731	2727	2724	2721	2717	2714	2711	2708	2705			3	9
40	2730	2726	2722	2719	2716	2712	2709	2706	2702	2699	2696	2693	2690			4	7
50	2715	2711	2707	2704	2701	2697	2694	2691	2687	2684	2681	2678	2675			5	6
55	0	2700	2696	2692	2689	2686	2682	2679	2676	2672	2669	2666	2663			6	4
10	2685	2681	2677	2674	2671	2667	2664	2661	2657	2654	2651	2648	2645			7	3
20	2670	2666	2662	2659	2656	2652	2649	2646	2642	2639	2636	2633	2630			8	1
30	2655	2651	2647	2644	2641	2637	2634	2631	2627	2624	2621	2618	2615			9	0
40	2640	2637	2633	2630	2627	2623	2620	2616	2613	2609	2606	2603	2600				
50	2625	2621	2618	2615	2612	2608	2605	2602	2599	2595	2592	2589	2586				
56	0	2610	2607	2603	2600	2597	2593	2590	2587	2584	2581	2577	2574			1	13
1	2590	2587	2583	2580	2576	2573	2570	2567	2563	2560	2557	2554	2551			2	12
20	2575	2571	2568	2565	2562	2558	2555	2552	2548	2545	2542	2539	2536			3	10
30	2560	2556	2553	2550	2546	2543	2540	2537	2533	2530	2527	2524	2521			4	9
40	2545	2541	2538	2535	2532	2528	2525	2522	2519	2515	2512	2509	2506			5	7
50	2530	2526	2523	2520	2517	2513	2510	2507	2504	2500	2497	2494	2491			6	6
57	0	2515	2511	2508	2505	2502	2498	2495	2492	2489	2485	2482	2479			7	3
10	2490	2487	2483	2480	2477	2474	2470	2467	2464	2461	2457	2454	2451			8	1
20	2475	2471	2468	2465	2462	2458	2455	2452	2448	2445	2442	2439	2436			9	0
30	2460	2456	2453	2450	2447	2443	2440	2437	2434	2430	2427	2424	2421				
40	2445	2441	2438	2435	2432	2428	2425	2422	2419	2415	2412	2409	2406				
50	2430	2426	2423	2420	2417	2413	2410	2407	2404	2400	2397	2394	2391				
58	0	2415	2411	2408	2405	2402	2398	2395	2392	2389	2385	2382	2379			0	13
10	2390	2387	2383	2380	2377	2374	2370	2367	2364	2361	2357	2354	2351			1	12
20	2375	2371	2368	2365	2362	2358	2355	2352	2348	2345	2342	2339	2336			2	10
30	2360	2356	2353	2350	2347	2343	2340	2337	2334	2330	2327	2324	2321			3	9
40	2345	2341	2338	2335	2332	2328	2325	2322	2319	2315	2312	2309	2306			4	8
50	2330	2326	2323	2320	2317	2313	2310	2307	2304	2300	2297	2294	2291			5	6
59	0	2315	2311	2308	2305	2302	2298	2295	2292	2289	2285	2282	2279			6	5
10	2290	2287	2283	2280	2277	2274	2270	2267	2264	2261	2257	2254	2251			7	3
20	2275	2271	2268	2265	2262	2258	2255	2252	2248	2245	2242	2239	2236			8	2
30	2260	2256	2253	2250	2247	2243	2240	2237	2234	2230	2227	2224	2221			9	1
40	2245	2241	2238	2235	2232	2228	2225	2222	2219	2215	2212	2209	2206				
50	2230	2226	2223	2220	2217	2213	2210	2207	2204	2200	2197	2194	2191				
60	0	2215	2211	2208	2205	2202	2198	2195	2192	2189	2185	2182	2179			0	13
10	2190	2187	2183	2180	2177	2174	2170	2167	2164	2161	2157	2154	2151			1	12
20	2175	2171	2168	2165	2162	2158	2155	2152	2148	2145	2142	2139	2136			2	10
30	2160	2156	2153	2150	2147	2143	2140	2137	2134	2130	2127	2124	2121			3	9
40	2145	2141	2138	2135	2132	2128	2125	2122	2119	2115	2112	2109	2106			4	8
50	2130	2126	2123	2120	2117	2113	2110	2107	2104	2100	2097	2094	2091			5	6
61	0	2115	2111	2108	2105	2102	2098	2095	2092	2089	2085	2082	2079			6	5
10	2090	2087	2083	2080	2077	2074	2070	2067	2064	2061	2057	2054	2051			7	4
20	2075	2071	2068	2065	2062	2058	2055	2052	2048	2045	2042	2039	2036			8	3
30	2060	2056	2053	2050	2047	2043	2040	2037	2034	2030	2027	2024	2021			9	1

TABLES XII, XIII, XIV, XV, AND XVI.

57

TABLE XII. The Refraction of the heavenly Bodies in Altitude.

Alt.	App. Alt.	Ref.	App. Alt.	Ref.
D. M. S.	D. M. S.	D. M. S.	D. M. S.	D. M. S.
0	6 30 7	52	30	1 38
11	6 40 7	41	31	1 35
22	6 50 7	31	32	1 31
36	7 07 21		33	1 28
50	7 10 7	12	34	1 24
6	7 20 7	3	35	1 21
23	7 30 6	54	36	1 18
41	7 40 6	45	37	1 16
0	7 50 6	38	38	1 13
20	8 06 30	39	39	1 10
42	8 10 6	22	40	1 8
5	8 20 6	15	41	1 5
29	8 30 6	8	42	1 3
54	8 40 6	1	43	1 1
20	8 50 5	55	44	0 59
47	9 05 49		45	0 57
15	9 10 5	43	46	0 55
38	9 20 5	37	47	0 53
16	9 30 5	31	48	0 51
46	9 40 5	26	49	0 50
18	9 50 5	20	50	0 48
51	10 05 15	61	51	0 45
25	10 15 5	8	52	0 43
59	10 30 5	0	53	0 43
36	10 45 4	54	54	0 41
11	11 04 47	55	55	0 40
48	11 15 4	41	56	0 38
26	11 30 4	35	57	0 37
4	11 45 4	29	58	0 36
44	12 04 23	59	59	0 34
23	12 20 4	16	60	0 32
2	12 40 4	9	61	0 32
46	13 04 3	62	62	0 30
27	13 20 3	57	63	0 29
9	13 40 3	51	64	0 28
62	14 03 46		65	0 27
36	14 20 3	40	66	0 26
19	14 40 3	35	67	0 24
3	15 03 30	63	68	0 23
42	15 30 3	23	69	0 22
33	16 03 17	70	70	0 21
19	16 30 3	11	71	0 20
5	17 03 5	72	72	0 19
39	17 30 2	59	73	0 17
14	18 02 54	74	74	0 16
50	18 30 2	42	75	0 15
28	19 02 44	76	76	0 14
7	19 30 2	40	77	0 13
47	20 02 36	78	78	0 12
28	20 30 2	32	79	0 11
10	21 02 28	80	80	0 10
53	21 30 2	24	81	0 9
37	22 02 20	82	82	0 8
21	23 02 14	83	83	0 7
7	24 02 7	84	84	0 6
53	25 02 2	85	85	0 5
39	26 01 56	86	86	0 4
27	27 01 51	87	87	0 3
15	28 01 47	88	88	0 2
3	29 01 43	89	89	0 1

TABLE XIII. Depression or Dip of the Horizon of the sea.

Height of the eye	Dip of the Horizon
Feet.	M. S.
1	0.59
2	1.24
3	1.42
4	1.58
5	2.12
6	2.25
7	2.36
8	2.47
9	2.57
10	3.7
11	3.16
12	3.25
13	3.34
14	3.41
15	3.48
16	3.55
17	4.3
18	4.11
19	4.17
20	4.24
21	4.31
22	4.37
23	4.43
24	4.49
25	5.1
26	5.13
27	5.15
28	5.17
29	5.19
30	5.21
35	5.49
45	6.14
50	6.36
60	7.37
70	8.14
80	8.48
90	9.20
100	9.51

TABLE XIV. The Sun's Parallax in Altitude.

Sun's Alt.	Sun's Parallax
D.	S.
0	9
10	9
20	8
30	8
40	7
50	6
55	6
60	4
65	4
70	3
75	2
80	2
85	1
90	0

TABLE XV. Augmentation of the Moon's Semi-diameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	5
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80	15
90	16

TABLE XVI. Dip of the Sea at different Distances from the Observer.

Dist. of the land in Sea miles.	Height of the Eye above the Sea in Feet.							
	5	10	15	20	25	30	35	40
	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.
	M.	M.	M.	M.	M.	M.	M.	M.
1	11	23	34	45	57	68	79	91
2	12	12	17	23	28	34	40	46
3	4	8	12	15	19	23	27	30
4	3	6	9	12	15	17	20	23
5	3	5	7	10	12	14	16	19
6	3	4	6	8	10	12	14	16
7	2	4	5	7	8	9	11	12
8	2	3	4	6	7	8	9	10
9	2	3	4	5	6	7	8	9
10	2	3	4	5	6	6	7	8
11	2	3	4	5	5	6	7	7
12	2	3	4	4	5	6	6	7
13	2	3	4	4	5	5	6	6
14	2	3	4	4	4	5	5	6
15	2	3	4	4	4	5	5	5

TABLE XVI.—The numbers of this table below the black lines, are the same given in Table XIII the visible horizon, corresponding to those heights, so far distant as the land.

TABLE XVII.

WHEN A STAR IS USED.

*Ap. Alt.	Cor.	Log.	*Ap. Alt.	Cor.	Log.	*Ap. Alt.	Cor.	Log.	*Ap. Alt.	Cor.	Log.	*Ap. Alt.	Cor.	Log.				
D M S			D M S			D M S			D M S			D M S						
5.0	0	0000	10.0	0.54	45	2277	13.15	56	2	1.3433	19.0	57	16	1.4925				
10	50	240	9700	3.54	47	2297	20.56	3	1.3450	10.57	17	1.4940	37	0.58	45	1.7517		
20	50	360	9817	6.54	48	2317	25.56	5	1.3465	20.57	19	1.4955	30.58	46	1.7618			
30	50	480	9930	9.54	50	2337	30.56	6	1.3511	30.57	20	1.5031	38	0.58	47	1.7668		
40	51	8	10041	12.54	51	2357	35.56	8	1.3557	40.57	22	1.5045	40.58	48	1.7717			
50	51	21	10150	15.54	53	2377	40.56	9	1.3562	50.57	23	1.5101	50.58	50	1.7766			
6.0	51	34	10256	18.54	54	2397	45.56	10	1.3587	60.57	25	1.5135	59.58	51	1.7810			
10	51	46	10360	21.54	56	2417	50.56	12	1.3612	10.57	26	1.5170	40	0.58	52	1.7854		
20	51	57	10462	24.54	57	2437	55.56	13	1.3637	20.57	27	1.5204	30.58	53	1.7900			
30	52	9	10562	27.54	58	2457	14.0	0.56	15	1.3662	30.57	29	1.5238	41	0.58	54	1.7946	
40	52	19	10660	30.55	0	2476	5.56	16	1.3687	40.57	30	1.5271	30.58	55	1.7987			
50	52	29	10755	33.55	1	2495	10.56	17	1.3711	50.57	31	1.5304	42	0.58	57	1.8028		
7.0	52	39	10849	36.56	3	2515	14.15	56	13	1.3735	21.0	57	33	1.5338	42.50	56	58	1.8070
10	52	49	10941	39.56	4	2534	20.56	20	1.3759	10.57	34	1.5370	43	0.58	58	1.8112		
20	52	58	11032	42.56	5	2553	25.56	21	1.3783	20.57	35	1.5401	30.58	0	1.8153			
30	53	6	11120	45.56	7	2572	30.56	22	1.3807	30.57	36	1.5432	44	0.58	1	1.8198		
38	53	11	11164	48.56	8	2591	35.56	24	1.3831	40.57	37	1.5463	30.58	2	1.8230			
40	53	15	11207	51.56	9	2610	40.56	25	1.3855	50.57	39	1.5494	45	0.58	3	1.8268		
7.46	53	19	11240	54.56	11	2629	45.56	26	1.3878	22.0	57	40	1.5525	46	59	4	1.8308	
48	53	21	11273	57.56	12	2648	50.56	28	1.3901	10.57	41	1.5556	47	59	7	1.8341		
51	53	24	11301	11.0	13	2667	55.56	29	1.3924	20.57	42	1.5586	48	59	10	1.8378		
54	53	26	11326	14.0	14	2686	10.0	30	1.3947	30.57	43	1.5616	49	11	1	1.8417		
57	53	28	11351	17.0	15	2705	5.0	31	1.3970	40.57	44	1.5646	50	59	12	1.8451		
8.0	53	30	11376	20.0	16	2724	10.56	32	1.3993	50.57	45	1.5676	51	59	14	1.8476		
8.3	53	33	11401	23.0	17	2742	15.56	33	1.4016	23.0	57	46	1.5709	52	59	16	1.8514	
6	53	35	11425	26.0	18	2760	20.56	34	1.4039	10.57	47	1.5739	53	59	17	1.8549		
9	53	37	11450	29.0	19	2777	25.56	35	1.4061	20.57	48	1.5769	54	59	19	1.8586		
12	53	39	11474	32.0	20	2796	30.56	37	1.4083	30.57	49	1.5798	55	59	21	1.8620		
15	53	42	11498	35.0	21	2814	35.56	38	1.4105	40.57	51	1.5825	56	59	23	1.8656		
18	53	44	11523	38.0	22	2832	40.56	39	1.4127	50.57	52	1.5850	57	59	24	1.8685		
8.21	53	46	11547	41.0	23	2850	45.56	40	1.4149	24.0	57	53	1.5879	58	59	26	1.8720	
24	53	48	11571	44.0	24	2868	50.56	41	1.4171	10.57	54	1.5907	59	59	27	1.8754		
27	53	50	11595	47.0	25	2886	55.56	42	1.4193	20.57	55	1.5935	60	59	29	1.8788		
30	53	52	11619	50.0	26	2904	16.0	56	43	1.4214	30.57	56	1.5963	61	59	31	1.8823	
33	53	54	11642	53.0	27	2922	5.0	56	44	1.4236	40.57	57	1.5991	62	59	33	1.8856	
36	53	56	11666	56.0	28	2940	10.56	45	1.4258	50.57	58	1.6019	63	59	35	1.8890		
8.30	53	58	11690	59.0	29	2957	15.56	46	1.4279	25.0	57	59	1.6044	64	59	37	1.8924	
42	54	0	11712	62.0	30	2974	20.56	47	1.4300	10.57	60	1.6072	65	59	39	1.8958		
45	54	2	11736	65.0	31	2991	25.56	48	1.4321	20.57	61	1.6100	66	59	41	1.8992		
48	54	4	11759	68.0	32	3008	30.56	49	1.4342	30.57	62	1.6128	67	59	43	1.9026		
51	54	6	11781	71.0	33	3025	35.56	50	1.4363	40.57	63	1.6156	68	59	45	1.9060		
54	54	8	11804	74.0	34	3042	40.56	51	1.4384	50.57	64	1.6184	69	59	47	1.9094		
8.37	54	10	11826	77.0	35	3059	45.56	52	1.4405	27.0	58	9	1.6209	70	59	49	1.9128	
9.0	54	12	11849	80.0	36	3076	50.56	53	1.4425	20.58	10	1.6230	71	59	51	1.9162		
3	54	13	11871	83.0	37	3093	55.56	54	1.4446	40.58	12	1.6249	72	59	53	1.9196		
6	54	15	11893	86.0	38	3110	10.0	56	56	1.4465	28.0	58	13	1.6268	73	59	55	1.9230
9	54	17	11916	89.0	39	3127	5.0	56	57	1.4485	20.58	15	1.6285	74	59	57	1.9264	
12	54	19	11938	92.0	40	3144	10.56	57	1.4506	40.58	16	1.6301	75	59	59	1.9298		
9.15	54	21	11960	95.0	41	3161	15.56	58	1.4526	29.0	58	18	1.6325	76	59	61	1.9332	
18	54	23	11982	98.0	42	3178	20.56	59	1.4546	30.58	20	1.6349	77	59	63	1.9366		
21	54	25	12003	101.0	43	3194	25.57	0	1.4566	30.58	22	1.6370	78	59	65	1.9400		
24	54	26	12025	104.0	44	3211	30.57	1	1.4586	30.58	24	1.6393	79	59	67	1.9434		
27	54	28	12047	107.0	45	3227	35.57	2	1.4606	31.0	58	25	1.6416	80	59	69	1.9468	
30	54	29	12069	110.0	46	3243	40.57	3	1.4626	30.58	27	1.6437	81	59	71	1.9502		
9.23	54	31	12090	113.0	47	3259	45.57	4	1.4646	32.0	58	29	1.6458	82	59	73	1.9536	
36	54	33	12110	116.0	48	3275	50.57	5	1.4666	30.58	31	1.6479	83	59	75	1.9570		
39	54	34	12132	119.0	49	3291	55.57	6	1.4686	33.0	58	33	1.6500	84	59	77	1.9604	
42	54	36	12153	122.0	50	3307	10.0	57	1.4703	30.58	35	1.6521	85	59	79	1.9638		
45	54	37	12175	125.0	51	3323	15.57	8	1.4723	34.0	58	37	1.6542	86	59	81	1.9672	
48	54	39	12196	128.0	52	3339	20.57	9	1.4743	30.58	39	1.6563	87	59	83	1.9706		
9.31	54	41	12215	131.0	53	3355	25.57	11	1.4763	33.0	58	41	1.6584	88	59	85	1.9740	
54	54	42	12237	134.0	54	3371	30.57	13	1.4782	30.58	43	1.6605	89	59	87	1.9774		
57	54	44	12257	137.0	55	3387	35.57	14	1.4802	36.0	58	45	1.6626	90	59	89	1.9808	

TABLE XVIII.

89

WHEN THE SUN IS USED.

Ap. Alt.	Cor.	Log.	Ap. Alt.	Cor.	Log.	Ap. Alt.	Cor.	Log.	Ap. Alt.	Cor.	Log.	Ap. Alt.	Cor.	Log.
D M M S			D M M S			D M M S			D M M S			D M M S		
5.0	50 16.0	1.287	10.0	54.34	1.287	13.15	56.10	1.3592	19.0	57.54	1.5148	26.30	56.50	1.7654
10	50.320	1.287	3.54	54.35	1.2418	20.36	56.12	1.3819	10.57	57.55	1.5177	37.0	56.51	1.7660
20	50.480	1.287	6.54	54.37	1.2430	25.56	56.13	1.3846	20.57	57.57	1.5225	30.58	56.53	1.8045
30	51.130	1.287	9.54	54.38	1.2460	30.56	56.15	1.3872	30.57	58.00	1.5282	38.0	56.54	1.8100
40	51.16	1.0113	12.55	0	1.2481	35.56	56.16	1.3909	40.57	58.01	1.5299	30.58	56.55	1.8154
50	51.20	1.0225	15.55	1	1.2501	40.56	56.17	1.3925	50.57	58.01	1.5336	30.58	56.57	1.8206
6.0	51.12	1.0339	18.55	2	1.2522	45.56	56.18	1.3951	20.57	58.33	1.5372	30.58	56.58	1.8257
10	51.35	1.0457	21.55	3	1.2543	50.56	56.20	1.3977	10.57	58.34	1.5406	40.58	56.59	1.8307
20	52.6	1.0581	24.56	4	1.2563	55.56	56.22	1.3993	20.57	58.35	1.5444	50.58	56.60	1.8357
30	52.17	1.0712	27.56	5	1.2583	13.0	56.23	1.3989	30.57	58.37	1.5470	41.0	56.61	1.8408
40	52.28	1.0757	30.56	6	1.2603	18.0	56.24	1.3993	40.57	58.38	1.5513	30.58	56.62	1.8459
50	52.39	1.0809	33.56	10	1.2623	10.56	56.26	1.3978	50.57	58.39	1.5550	42.0	56.63	1.8500
7.0	52.2	1.0934	10.56	11	1.2643	14.15	56.27	1.3994	21.0	58.41	1.5585	12.30	56.64	1.8548
10	52.77	1.1062	13.56	12	1.2663	20.56	56.28	1.3999	10.57	58.42	1.5619	43.0	56.65	1.8593
20	53.6	1.1192	42.56	13	1.2683	25.56	56.29	1.3995	20.57	58.43	1.5653	30.59	56.66	1.8638
30	53.15	1.1321	45.56	14	1.2702	30.56	56.31	1.3999	30.57	58.44	1.5688	44.0	56.67	1.8683
40	53.15	1.1457	48.56	15	1.2722	35.56	56.32	1.4001	40.57	58.45	1.5719	30.59	56.68	1.8727
50	53.25	1.1590	51.56	16	1.2742	40.56	56.33	1.4002	50.57	58.47	1.5752	45.0	56.69	1.8772
7.45	53.57	1.1717	10.56	17	1.2762	45.56	56.34	1.4003	22.0	58.48	1.5785	46.0	56.70	1.8816
48	53.57	1.1851	13.56	18	1.2782	50.56	56.35	1.4007	10.57	58.49	1.5817	47.0	56.71	1.8861
51	53.57	1.1987	16.56	19	1.2802	55.56	56.37	1.4001	20.57	58.50	1.5850	48.0	56.72	1.8905
54	53.57	1.2121	19.56	20	1.2822	10.56	56.38	1.4005	30.57	58.51	1.5882	49.0	56.73	1.8949
57	53.57	1.2257	22.56	21	1.2842	15.56	56.39	1.4009	40.57	58.52	1.5915	50.0	56.74	1.8993
8.0	53.59	1.2391	25.56	22	1.2862	20.56	56.41	1.4013	50.57	58.53	1.5948	51.0	56.75	1.9037
8.3	53.41	1.2527	11.56	23	1.2882	25.56	56.42	1.4017	23.0	58.54	1.5980	52.0	56.76	1.9081
6	53.41	1.2661	14.56	24	1.2902	30.56	56.43	1.4021	10.57	58.55	1.6012	53.0	56.77	1.9125
9	53.46	1.2795	17.56	25	1.2922	35.56	56.44	1.4025	20.57	58.56	1.6044	54.0	56.78	1.9169
12	53.48	1.2929	20.56	26	1.2942	40.56	56.45	1.4029	30.57	58.57	1.6076	55.0	56.79	1.9213
15	53.49	1.3063	23.56	27	1.2962	45.56	56.46	1.4033	40.57	58.58	1.6108	56.0	56.80	1.9257
18	53.52	1.3197	26.56	28	1.2982	50.56	56.47	1.4037	50.57	58.59	1.6140	57.0	56.81	1.9301
8.21	53.55	1.3331	11.56	29	1.3002	15.56	56.48	1.4041	21.0	58.60	1.6172	58.0	56.82	1.9345
24	53.57	1.3465	14.56	30	1.3022	20.56	56.49	1.4045	10.57	58.61	1.6204	59.0	56.83	1.9389
27	53.59	1.3599	17.56	31	1.3042	25.56	56.50	1.4049	20.57	58.62	1.6236	60.0	56.84	1.9433
30	54.1	1.3733	20.56	32	1.3062	30.56	56.51	1.4053	30.57	58.63	1.6268	61.0	56.85	1.9477
33	54.1	1.3867	23.56	33	1.3082	35.56	56.52	1.4057	40.57	58.64	1.6300	62.0	56.86	1.9521
36	54.1	1.3999	26.56	34	1.3102	40.56	56.53	1.4061	50.57	58.65	1.6332	63.0	56.87	1.9565
8.29	54.7	1.4133	11.56	35	1.3122	45.56	56.54	1.4065	23.0	58.66	1.6364	64.0	56.88	1.9609
42	54.9	1.4267	14.56	36	1.3142	50.56	56.55	1.4069	10.57	58.67	1.6396	65.0	56.89	1.9653
45	54.11	1.4401	17.56	37	1.3162	55.56	56.56	1.4073	20.57	58.68	1.6428	66.0	56.90	1.9697
48	54.13	1.4535	20.56	38	1.3182	10.56	56.57	1.4077	30.57	58.69	1.6460	67.0	56.91	1.9741
51	54.15	1.4669	23.56	39	1.3202	15.56	56.58	1.4081	40.57	58.70	1.6492	68.0	56.92	1.9785
54	54.16	1.4803	26.56	40	1.3222	20.56	56.59	1.4085	50.57	58.71	1.6524	69.0	56.93	1.9829
8.57	54.18	1.4937	29.56	41	1.3242	25.56	56.60	1.4089	23.0	58.72	1.6556	70.0	56.94	1.9873
9.0	54.20	1.5071	32.56	42	1.3262	30.56	56.61	1.4093	10.57	58.73	1.6588	71.0	56.95	1.9917
3	54.22	1.5205	35.56	43	1.3282	35.56	56.62	1.4097	20.57	58.74	1.6620	72.0	56.96	1.9961
6	54.24	1.5339	38.56	44	1.3302	40.56	56.63	1.4101	30.57	58.75	1.6652	73.0	56.97	1.9995
9	54.26	1.5473	41.56	45	1.3322	45.56	56.64	1.4105	40.57	58.76	1.6684	74.0	56.98	2.0039
12	54.27	1.5607	44.56	46	1.3342	50.56	56.65	1.4109	50.57	58.77	1.6716	75.0	56.99	2.0083
9.13	54.29	1.5741	47.56	47	1.3362	55.56	56.66	1.4113	23.0	58.78	1.6748	76.0	57.00	2.0127
18	54.31	1.5875	50.56	48	1.3382	10.56	56.67	1.4117	30.57	58.79	1.6780	77.0	57.01	2.0171
21	54.32	1.6009	53.56	49	1.3402	15.56	56.68	1.4121	40.57	58.80	1.6812	78.0	57.02	2.0215
24	54.34	1.6143	56.56	50	1.3422	20.56	56.69	1.4125	50.57	58.81	1.6844	79.0	57.03	2.0259
27	54.36	1.6277	59.56	51	1.3442	25.56	56.70	1.4129	23.0	58.82	1.6876	80.0	57.04	2.0303
30	54.37	1.6411	62.56	52	1.3462	30.56	56.71	1.4133	30.57	58.83	1.6908	81.0	57.05	2.0347
9.23	54.39	1.6545	65.56	53	1.3482	35.56	56.72	1.4137	40.57	58.84	1.6940	82.0	57.06	2.0391
35	54.41	1.6679	68.56	54	1.3502	40.56	56.73	1.4141	50.57	58.85	1.6972	83.0	57.07	2.0435
38	54.43	1.6813	71.56	55	1.3522	45.56	56.74	1.4145	23.0	58.86	1.7004	84.0	57.08	2.0479
42	54.44	1.6947	74.56	56	1.3542	50.56	56.75	1.4149	30.57	58.87	1.7036	85.0	57.09	2.0523
45	54.46	1.7081	77.56	57	1.3562	55.56	56.76	1.4153	40.57	58.88	1.7068	86.0	57.10	2.0567
48	54.48	1.7215	80.56	58	1.3582	10.56	56.77	1.4157	50.57	58.89	1.7100	87.0	57.11	2.0611
51	54.50	1.7349	83.56	59	1.3602	15.56	56.78	1.4161	23.0	58.90	1.7132	88.0	57.12	2.0655
54	54.51	1.7483	86.56	60	1.3622	20.56	56.79	1.4165	30.57	58.91	1.7164	89.0	57.13	2.0699
57	54.52	1.7617	89.56	61	1.3642	25.56	56.80	1.4169	40.57	58.92	1.7196	90.0	57.14	2.0743

TABLE XIX.
CORRECTION.

AP Alt. Dist.	Sun's Horizontal Parallax										Table A Prop part for seconds of Paral Add										Table B For M of Alt. Add		
	54	55	56	57	58	59	60	61	62	63	50	51	52	53	54	55	56	57	58	59	60	61	
5	14	35	11	36	12	33	11	36	10	36	9	36	8	36	7	37	0	59	5	37	56	53	54
10	14	20	11	20	12	20	11	20	10	19	18	21	7	21	10	42	4	47	46	42	44	43	41
20	14	5	11	5	12	6	11	6	10	6	9	6	8	7	7	30	39	3	37	36	31	34	32
30	13	5	12	5	11	5	10	5	9	5	8	5	7	6	6	30	29	2	27	26	21	24	22
40	13	3	12	3	11	3	10	3	9	3	8	4	7	6	6	40	19	1	17	16	11	14	12
50	13	2	12	2	11	2	10	2	9	2	7	3	7	6	6	50	9	0	7	6	1	4	3
6	0	13	17	12	11	11	10	18	9	19	8	19	7	19	6	0	59	5	57	56	53	54	52
10	13	6	12	7	11	7	10	7	9	8	8	7	8	6	5	10	49	4	47	46	43	44	42
20	12	5	11	6	10	6	9	6	8	7	7	6	7	5	4	2	39	3	37	36	31	34	32
30	12	4	11	5	10	5	9	5	8	6	7	6	5	4	3	2	29	2	27	26	21	24	22
40	12	3	11	4	10	4	9	4	7	5	6	5	4	3	2	1	19	1	17	16	11	14	12
50	12	2	11	3	10	3	9	3	6	4	5	4	3	2	1	0	9	0	7	6	1	4	3
60	12	1	11	2	10	2	9	2	5	3	4	3	2	1	0	0	0	0	0	0	0	0	0
7	0	12	18	11	19	10	19	9	19	8	20	7	20	6	21	5	21	5	20	19	16	17	15

AP Alt. Dist.	Table A Prop part for seconds of Paral Add										Table B For M of Alt. Add										Table C For S of Paral Add		
	54	55	56	57	58	59	60	61	62	63	50	51	52	53	54	55	56	57	58	59	60	61	
5	14	35	11	36	12	33	11	36	10	36	9	36	8	36	7	37	0	59	5	37	56	53	54
10	14	20	11	20	12	20	11	20	10	19	18	21	7	21	10	42	4	47	46	42	44	43	41
20	14	5	11	5	12	6	11	6	10	6	9	6	8	7	7	30	39	3	37	36	31	34	32
30	13	5	12	5	11	5	10	5	9	5	8	5	7	6	6	30	29	2	27	26	21	24	22
40	13	3	12	3	11	3	10	3	9	3	8	4	7	6	6	40	19	1	17	16	11	14	12
50	13	2	12	2	11	2	10	2	9	2	7	3	7	6	6	50	9	0	7	6	1	4	3
6	0	13	17	12	11	11	10	18	9	19	8	19	7	19	6	0	59	5	57	56	53	54	52
10	13	6	12	7	11	7	10	7	9	8	8	7	8	6	5	10	49	4	47	46	43	44	42
20	12	5	11	6	10	6	9	6	8	7	7	6	7	5	4	2	39	3	37	36	31	34	32
30	12	4	11	5	10	5	9	5	8	6	7	6	5	4	3	2	29	2	27	26	21	24	22
40	12	3	11	4	10	4	9	4	7	5	6	5	4	3	2	1	19	1	17	16	11	14	12
50	12	2	11	3	10	3	9	3	6	4	5	4	3	2	1	0	9	0	7	6	1	4	3
60	12	1	11	2	10	2	9	2	5	3	4	3	2	1	0	0	0	0	0	0	0	0	0
7	0	12	18	11	19	10	19	9	19	8	20	7	20	6	21	5	21	5	20	19	16	17	15

TABLE XIX.

91

CORRECTION.

D's Horizontal Parallax.								TABLE A. Proportional part for Seconds of Parallax Add										Tab. B. For M of alt. Add.		
1'	55'	56'	57'	58'	59'	60'	61'	S	0	1	2	3	4	5	6	7	8	9	M	S
.21	11.22	10.22	9.22	8.23	7.23	6.24	5.24	0	59	58	57	56	55	54	53	52	51	50		
.13	11.13	10.14	9.14	8.15	7.15	6.16	5.16	10	49	48	47	46	45	44	43	42	41	40		
.51	11.51	10.51	9.51	8.52	7.52	6.53	5.53	20	39	38	37	36	35	34	33	32	31	30		
.58	10.58	9.59	8.59	8.07	7.07	6.15	5.15	30	29	28	27	26	25	24	23	22	21	20		
.50	10.51	9.51	8.52	7.53	6.53	5.54	4.54	40	19	18	17	16	15	14	13	12	11	10		
								50	9	8	7	6	5	4	3	2	1	0		

TABLE XIX LOGARITHMS.

Apparent Altitude of D's centre.																TABLE C. Cor for Seconds of Parallax. Add.	
																S.	Cor.
37	67	97	127	157	187	217	247	277	307	337	36					0	13
41	2836	2831	2827	2823	2819	2815	2811	2807	2803	2799	2795					1	12
25	2821	2816	2812	2808	2804	2800	2796	2791	2787	2783	2780					2	10
10	2805	2800	2796	2792	2788	2784	2780	2776	2772	2768	2765					3	9
94	2790	2785	2781	2777	2773	2769	2765	2761	2757	2753	2749					4	7
79	2774	2770	2766	2762	2758	2754	2750	2746	2742	2738	2734					5	6
64	2759	2755	2751	2747	2743	2739	2735	2731	2727	2723	2719					6	4
48	2744	2739	2735	2731	2727	2723	2719	2716	2712	2708	2704					7	3
33	2729	2724	2720	2716	2712	2708	2704	2700	2696	2692	2689					8	1
18	2714	2709	2705	2701	2697	2693	2689	2685	2681	2677	2674					9	0
03	2699	2694	2690	2686	2682	2678	2674	2671	2667	2663	2659					S.	Cor.
88	2684	2679	2675	2671	2667	2663	2659	2656	2652	2648	2644					0	13
73	2669	2664	2660	2656	2653	2649	2645	2641	2637	2633	2630					1	12
58	2654	2649	2645	2641	2638	2634	2630	2626	2622	2618	2615					2	10
43	2639	2634	2631	2627	2623	2619	2615	2611	2607	2603	2600					3	9
28	2624	2620	2616	2612	2608	2604	2600	2597	2593	2589	2586					4	7
14	2610	2606	2602	2598	2594	2590	2586	2582	2578	2574	2571					5	6
99	2595	2591	2587	2583	2579	2575	2571	2567	2563	2559	2556					6	4
84	2580	2576	2572	2568	2564	2560	2556	2553	2549	2545	2542					7	3
70	2566	2562	2558	2554	2550	2546	2542	2538	2534	2530	2527					8	1
55	2551	2547	2543	2539	2535	2531	2527	2524	2520	2516	2513					9	0
40	2536	2532	2528	2524	2521	2517	2513	2510	2506	2502	2499					S.	Cor.
26	2522	2518	2514	2510	2506	2503	2499	2495	2491	2487	2484					0	13
12	2508	2504	2500	2496	2492	2488	2484	2481	2477	2473	2470					1	12
97	2493	2489	2485	2481	2478	2474	2470	2467	2463	2459	2456					2	10
83	2479	2475	2471	2467	2463	2460	2456	2452	2448	2444	2441					3	9
69	2465	2461	2457	2453	2449	2445	2441	2438	2434	2430	2427					4	7
54	2450	2446	2442	2438	2435	2431	2427	2424	2420	2416	2413					5	6
40	2436	2432	2428	2424	2421	2417	2413	2410	2406	2402	2399					6	4
26	2422	2418	2414	2410	2407	2403	2399	2396	2392	2388	2385					7	3
12	2407	2403	2399	2396	2393	2389	2385	2382	2378	2374	2371					8	1
98	2394	2390	2386	2382	2379	2375	2371	2368	2364	2360	2357					9	0
84	2380	2376	2372	2368	2365	2361	2357	2354	2350	2346	2343					S.	Cor.
70	2366	2362	2358	2354	2351	2347	2343	2340	2336	2332	2329					0	13
56	2352	2348	2345	2341	2337	2334	2330	2327	2323	2319	2316					1	12
42	2338	2334	2331	2327	2323	2320	2316	2313	2309	2305	2302					2	10
28	2324	2320	2317	2313	2309	2306	2302	2299	2295	2291	2288					3	9
14	2311	2307	2303	2299	2296	2292	2289	2286	2282	2278	2275					4	7
01	2297	2293	2290	2286	2282	2279	2275	2272	2268	2264	2261					5	6
87	2283	2279	2276	2272	2268	2265	2261	2258	2254	2250	2247					6	4
73	2270	2266	2262	2258	2255	2251	2248	2245	2241	2237	2234					7	3
60	2256	2252	2249	2245	2241	2238	2234	2231	2227	2223	2220					8	1
46	2243	2239	2235	2231	2228	2224	2221	2218	2214	2210	2207					9	0
33	2229	2225	2222	2218	2214	2211	2207	2204	2200	2196	2193					S.	Cor.
19	2216	2212	2209	2205	2201	2198	2194	2191	2187	2183	2180					0	13
06	2202	2198	2195	2191	2187	2184	2181	2178	2174	2170	2167					1	12
92	2189	2185	2182	2178	2174	2171	2167	2164	2160	2157	2154					2	10

TABLE XIX.

CORRECTION.

D. M.	D's Horizontal Parallax										TABLE A. Proportional part for Seconds of Parallax Add										Tab. B For M of alt. Add.	
	54'	55'	56'	57'	58'	59'	60'	61'			5	6	7	8	9	M	S					
	7	30	11	58	10	58	9	59	8	59	8	6	7	6	5	4	3	2	1	0		
	40	11	50	10	51	9	51	8	52	7	53	6	53	5	4	3	2	1	0			
	50	11	44	10	44	9	45	8	45	7	46	6	46	5	4	3	2	1	0			
8	0	11	37	10	38	9	38	8	39	7	40	6	40	5	3	2	1	0				
	10	11	31	10	32	9	32	8	33	7	33	6	34	5	3	2	1	0				
	20	11	25	10	26	9	26	8	27	7	27	6	28	5	2	1	0					
TABLE XIX LOGARITHMS																						
D's Hor. Parallax M.	Apparent Altitude of D's centre										TABLE C Cor for Seconds of Parallax. Add											
	0	1	2	3	4	5	6	7	8	9	S.	Cor.										
54	0	2791	2787	2783	2780	2777	2774	2770	2766	2762	0	13										
	10	2776	2772	2768	2765	2762	2759	2755	2751	2747	1	12										
	20	2761	2757	2753	2750	2747	2743	2739	2735	2731	2	10										
	30	2745	2741	2737	2734	2731	2727	2723	2719	2715	3	9										
	40	2730	2726	2722	2719	2715	2712	2708	2704	2700	4	7										
	50	2715	2711	2707	2704	2701	2697	2693	2689	2685	5	6										
55	0	2700	2696	2692	2689	2685	2682	2678	2674	2670	6	4										
	10	2685	2681	2677	2674	2670	2667	2663	2659	2655	7	3										
	20	2670	2666	2662	2659	2655	2652	2648	2644	2640	8	1										
	30	2655	2651	2647	2644	2640	2637	2633	2629	2625	9	0										
	40	2640	2637	2633	2630	2626	2623	2619	2615	2611												
	50	2626	2622	2618	2615	2611	2608	2604	2600	2596												
56	0	2611	2607	2603	2600	2597	2593	2589	2585	2581	0	13										
	10	2596	2592	2588	2585	2581	2578	2574	2570	2566	1	12										
	20	2582	2577	2574	2570	2566	2563	2559	2555	2551	2	10										
	30	2567	2563	2559	2556	2552	2548	2544	2540	2536	3	9										
	40	2552	2548	2544	2540	2537	2533	2529	2525	2521	4	7										
	50	2538	2534	2530	2526	2522	2518	2514	2510	2506	5	6										
57	0	2523	2519	2516	2512	2508	2504	2500	2496	2492	6	4										
	10	2488	2484	2480	2476	2472	2468	2464	2460	2456	7	3										
	20	2473	2469	2465	2461	2457	2453	2449	2445	2441	8	1										
	30	2458	2454	2450	2446	2442	2438	2434	2430	2426	9	0										
	40	2443	2439	2435	2431	2427	2423	2419	2415	2411												
	50	2428	2424	2420	2416	2412	2408	2404	2400	2396												
58	0	2413	2409	2405	2401	2397	2393	2389	2385	2381	0	13										
	10	2396	2392	2388	2384	2380	2376	2372	2368	2364	1	12										
	20	2381	2377	2373	2369	2365	2361	2357	2353	2349	2	10										
	30	2366	2362	2358	2354	2350	2346	2342	2338	2334	3	9										
	40	2351	2347	2343	2339	2335	2331	2327	2323	2319	4	7										
	50	2336	2332	2328	2324	2320	2316	2312	2308	2304	5	6										
59	0	2321	2317	2313	2309	2305	2301	2297	2293	2289	6	4										
	10	2284	2280	2276	2272	2268	2264	2260	2256	2252	7	3										
	20	2269	2265	2261	2257	2253	2249	2245	2241	2237	8	1										
	30	2254	2250	2246	2242	2238	2234	2230	2226	2222	9											
	40	2239	2235	2231	2227	2223	2219	2215	2211	2207												
	50	2224	2220	2216	2212	2208	2204	2200	2196	2192												
60	0	2209	2205	2201	2197	2193	2189	2185	2181	2177	0	13										
	10	2182	2178	2174	2170	2166	2162	2158	2154	2150	1	12										
	20	2167	2163	2159	2155	2151	2147	2143	2139	2135	2	10										
	30	2152	2148	2144	2140	2136	2132	2128	2124	2120	3	9										
	40	2137	2133	2129	2125	2121	2117	2113	2109	2105	4	8										
	50	2122	2118	2114	2110	2106	2102	2098	2094	2090	5	6										
61	0	2107	2103	2099	2095	2091	2087	2083	2079	2075	6	4										
	10	2080	2076	2072	2068	2064	2060	2056	2052	2048	7	3										
	20	2063	2059	2055	2051	2047	2043	2039	2035	2031	8	1										
	30	2046	2042	2038	2034	2030	2026	2022	2018	2014	9											
	40	2029	2025	2021	2017	2013	2009	2005	2001	1997												
	50	1992	1988	1984	1980	1976	1972	1968	1964	1960												

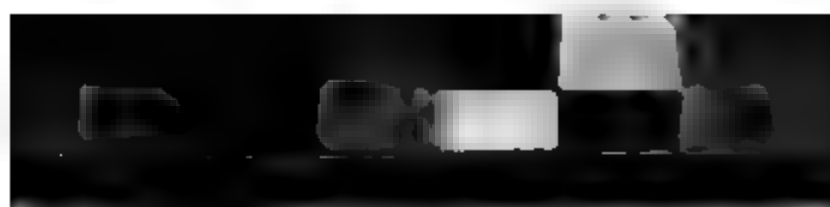


TABLE XIX.

99

CORRECTION.

J's Horizontal Parallax.							TABLE A Proportional part for Seconds of Parallax Add												Tab. B For M of Alt. Add.	
55'	56'	57'	58'	59'	60'	61'	S.	0	1	2	3	4	5	6	7	8	9	M	S	
10 34.9	34.8	35.7	35.6	36.5	37.4	37	0	58	57	56	55	54	53	52	51	50	49	0	5	
10.28.9	28.8	29.7	30.6	30.5	31.4	32	10	45	47	46	45	44	43	42	41	40	39	0	5	
10 22.9	23.8	24.7	24.6	25.5	26.4	26	20	38	37	36	35	34	33	32	31	30	29	0	5	
10 17.9	18.8	18.7	19.6	20.5	20.4	21	30	28	27	26	25	24	23	22	21	20	19	0	5	
10 12.9	13.8	13.7	14.6	15.5	15.4	16	40	18	17	16	15	14	13	12	11	10		0	5	
							50	9	8	7	6	5	4	3	2	1	0		0	

TABLE XIX. LOGARITHMS

Apparent Altitude of J's centre.												TABLE C. Cor. for Seconds of Parallax. Add.	
18.8	21	24.8	27.9	30	33.8	36.8	39.8	42.8	45.8	48		S.	Cor.
746	2715	2710	2717	2711	2731	2728	2725	2722	2719	2716		0	13
731	2725	2729	2727	2727	2714	2716	2713	2710	2707	2704	2701	1	12
716	2713	2710	2707	2704	2701	2698	2695	2692	2689	2686		2	10
701	2695	2695	2692	2689	2686	2683	2680	2677	2674	2671		3	9
686	2683	2680	2677	2674	2671	2668	2665	2662	2659	2656		4	7
671	2669	2666	2662	2659	2656	2653	2650	2647	2644	2641		5	6
656	2653	2650	2647	2644	2641	2638	2635	2632	2629	2627		6	4
641	2648	2645	2642	2639	2636	2633	2630	2627	2624	2621		7	3
626	2643	2640	2637	2634	2631	2628	2625	2622	2619	2616		8	1
612	2639	2636	2633	2630	2627	2624	2621	2618	2615	2612		9	0
597	2634	2631	2628	2625	2622	2619	2616	2613	2610	2607			
582	2629	2626	2623	2620	2617	2614	2611	2608	2605	2602		5	Cor.
567	2624	2621	2618	2615	2612	2609	2606	2603	2600	2597		0	13
552	2619	2616	2613	2610	2607	2604	2601	2598	2595	2592		1	12
537	2614	2611	2608	2605	2602	2599	2596	2593	2590	2587		2	10
522	2609	2606	2603	2600	2597	2594	2591	2588	2585	2582		3	9
507	2604	2601	2598	2595	2592	2589	2586	2583	2580	2577		4	7
492	2599	2596	2593	2590	2587	2584	2581	2578	2575	2572		5	6
477	2594	2591	2588	2585	2582	2579	2576	2573	2570	2567		6	4
462	2589	2586	2583	2580	2577	2574	2571	2568	2565	2562		7	3
447	2584	2581	2578	2575	2572	2569	2566	2563	2560	2557		8	1
432	2579	2576	2573	2570	2567	2564	2561	2558	2555	2552		9	0
417	2574	2571	2568	2565	2562	2559	2556	2553	2550	2547			
402	2569	2566	2563	2560	2557	2554	2551	2548	2545	2542		8	Cor.
387	2564	2561	2558	2555	2552	2549	2546	2543	2540	2537		0	13
372	2559	2556	2553	2550	2547	2544	2541	2538	2535	2532		1	12
357	2554	2551	2548	2545	2542	2539	2536	2533	2530	2527		2	10
342	2549	2546	2543	2540	2537	2534	2531	2528	2525	2522		3	9
327	2544	2541	2538	2535	2532	2529	2526	2523	2520	2517		4	7
312	2539	2536	2533	2530	2527	2524	2521	2518	2515	2512		5	6
297	2534	2531	2528	2525	2522	2519	2516	2513	2510	2507		6	5
282	2529	2526	2523	2520	2517	2514	2511	2508	2505	2502		7	3
267	2524	2521	2518	2515	2512	2509	2506	2503	2500	2497		8	2
252	2519	2516	2513	2510	2507	2504	2501	2498	2495	2492		9	1
237	2514	2511	2508	2505	2502	2499	2496	2493	2490	2487			
222	2509	2506	2503	2500	2497	2494	2491	2488	2485	2482		5	Cor.
207	2504	2501	2498	2495	2492	2489	2486	2483	2480	2477		0	13
192	2499	2496	2493	2490	2487	2484	2481	2478	2475	2472		1	12
177	2494	2491	2488	2485	2482	2479	2476	2473	2470	2467		2	10
162	2489	2486	2483	2480	2477	2474	2471	2468	2465	2462		3	9
147	2484	2481	2478	2475	2472	2469	2466	2463	2460	2457		4	7
132	2479	2476	2473	2470	2467	2464	2461	2458	2455	2452		5	6
117	2474	2471	2468	2465	2462	2459	2456	2453	2450	2447		6	5
102	2469	2466	2463	2460	2457	2454	2451	2448	2445	2442		7	3
87	2464	2461	2458	2455	2452	2449	2446	2443	2440	2437		8	2
72	2459	2456	2453	2450	2447	2444	2441	2438	2435	2432		9	1
57	2454	2451	2448	2445	2442	2439	2436	2433	2430	2427			
42	2449	2446	2443	2440	2437	2434	2431	2428	2425	2422		0	13
27	2444	2441	2438	2435	2432	2429	2426	2423	2420	2417		1	12
12	2439	2436	2433	2430	2427	2424	2421	2418	2415	2412		2	10
	2434	2431	2428	2425	2422	2419	2416	2413	2410	2407		3	9
	2429	2426	2423	2420	2417	2414	2411	2408	2405	2402		4	7
	2424	2421	2418	2415	2412	2409	2406	2403	2400	2397		5	6
	2419	2416	2413	2410	2407	2404	2401	2398	2395	2392		6	5
	2414	2411	2408	2405	2402	2399	2396	2393	2390	2387		7	3
	2409	2406	2403	2400	2397	2394	2391	2388	2385	2382		8	2
	2404	2401	2398	2395	2392	2389	2386	2383	2380	2377		9	1

TABLE XIX.

CONCLUSION.

App alt. = con	D's Horizontal Parallax										TABLE A Proportional part for Seconds of Parallax Add													TABLE B For nt alt Add						
	D M	54'	55'	56'	57'	58'	59'	60'	61'	S	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	M	S								
8.50	11	12	10	13	9	14	8	14	7	15	6	16	5	16	4	17		0	58	57	56	55	54	53	52	51	50	49		
9.0	11	7	10	8	9	9	8	10	7	10	6	11	5	12	4	13		10	48	47	46	45	44	43	42	41	40	39		
10	11	3	10	4	9	4	8	5	7	6	6	7	5	7	4	8		20	36	37	36	35	34	33	32	31	30	29		
20	10	59	9	59	9	0	8	17	20	20	23	34	4					30	28	27	26	25	24	23	22	21	20			
30	10	51	9	55	8	56	7	57	6	58	5	58	4	59	4	0		40	19	18	17	16	15	14	13	12	11	10		
																		50	9	8	7	6	5	4	3	2	1	0		

TABLE XIX
EXPOSITIONS

Declination Parallels		Apparent Altitude of Sun's centre.																				TABLE C Cor for Seconds of Parallax Add		
		M	S	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	S	Cor
54	0	271	271	271	270	270	269	269	268	268	267	267	266	266	265	265	264	264	263	263	262	262	0	13
	10	269	269	269	268	268	267	267	266	266	265	265	264	264	263	263	262	262	261	261	260	260	1	12
	20	267	267	267	266	266	265	265	264	264	263	263	262	262	261	261	260	260	259	259	258	258	2	10
	30	265	265	265	264	264	263	263	262	262	261	261	260	260	259	259	258	258	257	257	256	256	3	9
	40	263	263	263	262	262	261	261	260	260	259	259	258	258	257	257	256	256	255	255	254	254	4	7
	50	261	261	261	260	260	259	259	258	258	257	257	256	256	255	255	254	254	253	253	252	252	5	6
55	0	259	259	259	258	258	257	257	256	256	255	255	254	254	253	253	252	252	251	251	250	250	6	4
	10	257	257	257	256	256	255	255	254	254	253	253	252	252	251	251	250	250	249	249	248	248	7	3
	20	255	255	255	254	254	253	253	252	252	251	251	250	250	249	249	248	248	247	247	246	246	8	1
	30	253	253	253	252	252	251	251	250	250	249	249	248	248	247	247	246	246	245	245	244	244	9	0
	40	251	251	251	250	250	249	249	248	248	247	247	246	246	245	245	244	244	243	243	242	242		
	50	249	249	249	248	248	247	247	246	246	245	245	244	244	243	243	242	242	241	241	240	240	S	Cor
56	0	247	247	247	246	246	245	245	244	244	243	243	242	242	241	241	240	240	239	239	238	238	0	13
	10	245	245	245	244	244	243	243	242	242	241	241	240	240	239	239	238	238	237	237	236	236	1	12
	20	243	243	243	242	242	241	241	240	240	239	239	238	238	237	237	236	236	235	235	234	234	2	10
	30	241	241	241	240	240	239	239	238	238	237	237	236	236	235	235	234	234	233	233	232	232	3	9
	40	239	239	239	238	238	237	237	236	236	235	235	234	234	233	233	232	232	231	231	230	230	4	7
	50	237	237	237	236	236	235	235	234	234	233	233	232	232	231	231	230	230	229	229	228	228	5	6
57	0	235	235	235	234	234	233	233	232	232	231	231	230	230	229	229	228	228	227	227	226	226	6	4
	10	233	233	233	232	232	231	231	230	230	229	229	228	228	227	227	226	226	225	225	224	224	7	3
	20	231	231	231	230	230	229	229	228	228	227	227	226	226	225	225	224	224	223	223	222	222	8	1
	30	229	229	229	228	228	227	227	226	226	225	225	224	224	223	223	222	222	221	221	220	220	9	0
	40	227	227	227	226	226	225	225	224	224	223	223	222	222	221	221	220	220	219	219	218	218		
	50	225	225	225	224	224	223	223	222	222	221	221	220	220	219	219	218	218	217	217	216	216	S	Cor
58	0	223	223	223	222	222	221	221	220	220	219	219	218	218	217	217	216	216	215	215	214	214	0	13
	10	221	221	221	220	220	219	219	218	218	217	217	216	216	215	215	214	214	213	213	212	212	1	12
	20	219	219	219	218	218	217	217	216	216	215	215	214	214	213	213	212	212	211	211	210	210	2	10
	30	217	217	217	216	216	215	215	214	214	213	213	212	212	211	211	210	210	209	209	208	208	3	9
	40	215	215	215	214	214	213	213	212	212	211	211	210	210	209	209	208	208	207	207	206	206	4	7
	50	213	213	213	212	212	211	211	210	210	209	209	208	208	207	207	206	206	205	205	204	204	5	6
59	0	211	211	211	210	210	209	209	208	208	207	207	206	206	205	205	204	204	203	203	202	202	6	4
	10	209	209	209	208	208	207	207	206	206	205	205	204	204	203	203	202	202	201	201	200	200	7	3
	20	207	207	207	206	206	205	205	204	204	203	203	202	202	201	201	200	200	199	199	198	198	8	1
	30	205	205	205	204	204	203	203	202	202	201	201	200	200	199	199	198	198	197	197	196	196	9	
	40	203	203	203	202	202	201	201	200	200	199	199	198	198	197	197	196	196	195	195	194	194		
	50	201	201	201	200	200	199	199	198	198	197	197	196	196	195	195	194	194	193	193	192	192	S	Cor.
60	0	200	200	200	199	199	198	198	197	197	196	196	195	195	194	194	193	193	192	192	191	191	0	13
	10	198	198	198	197	197	196	196	195	195	194	194	193	193	192	192	191	191	190	190	189	189	1	12
	20	196	196	196	195	195	194	194	193	193	192	192	191	191	190	190	189	189	188	188	187	187	2	10
	30	194	194	194	193	193	192	192	191	191	190	190	189	189	188	188	187	187	186	186	185	185	3	9
	40	192	192	192	191	191	190	190	189	189	188	188	187	187	186	186	185	185	184	184	183	183	4	7
	50	190	190	190	189	189	188	188	187	187	186	186	185	185	184	184	183	183	182	182	181	181	5	6
61	0	188	188	188	187	187	186	186	185	185	184	184	183	183	182	182	181	181	180	180	179	179	6	4
	10	186	186	186	185	185	184	184	183	183	182	182	181	181	180	180	179	179	178	178	177	177	7	3
	20	184	184	184	183	183	182	182	181	181	180	180	179	179	178	178	177	177	176	176	175	175	8	1
	30	182	182	182	181	181	180	180	179	179	178	178	177	177	176	176	175	175	174	174	173	173	9	
	40	180	180	180	179	179	178	178	177	177	176	176	175	175	174	174	173	173	172	172	171	171		
	50	178	178	178	177	177	176	176	175	175	174	174	173	173	172	172	171	171	170	170	169	169	S	Cor.

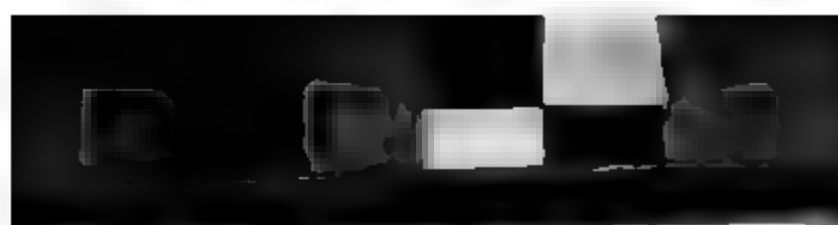


TABLE XIX.

95

CORRECTION.

J's Horizontal Parallax.							TABLE. A. Proportional part for Seconds of Parallax. Add											Tab. B. Form of alt. Add.	
58'	56'	57'	58'	59'	60'	61'	5	0	1	2	3	4	5	6	7	8	9	M	S
9.56.8	57.7	58.6	59.5	59.5	0.4	1	0	58	57	56	55	54	53	52	51	50	49		
9.52.8	53.7	54.6	55.5	56.4	56.3	5.7	10	48	47	46	45	44	43	42	41	40	39		
9.49.8	49.7	50.6	51.5	52.4	53.3	5.4	20	38	37	36	35	34	33	32	31	30	29		
9.45.8	45.7	46.6	47.5	48.4	49.3	5.0	30	28	27	26	25	24	23	22	21	20	19		
9.42.8	42.7	43.6	44.5	45.4	46.3	4.7	40	19	18	17	16	15	14	13	12	11	10		
9.39.8	40.7	41.6	42.5	43.4	44.3	4.4	50	9	8	7	6	5	4	3	2	1	0		

TABLE XIX. LOGARITHMS

Apparent Altitude of J's centre.														TABLE C. Cor. for Seconds of Parallax. Add.	
10	10	10	10	10	10	10	10	10	10	10	10	10	10	S.	Cor.
34.9	38.9	42.9	46.9	50.9	54.9	58.10	2	10	6	10	10	10	14	10	18
676	2673	2669	2666	2663	2660	2657	2654	2651	2648	2645	2642	2639	2636	0	13
661	2658	2654	2651	2648	2645	2642	2640	2637	2634	2631	2628	2625	2622	1	12
646	2643	2639	2636	2633	2630	2627	2625	2622	2619	2616	2613	2610	2607	2	10
631	2628	2624	2621	2618	2615	2612	2610	2607	2604	2601	2598	2595	2592	3	9
616	2613	2610	2607	2604	2601	2598	2595	2592	2589	2587	2584	2581	2578	4	7
602	2599	2595	2592	2589	2586	2583	2581	2578	2575	2572	2569	2566	2563	5	6
587	2584	2580	2577	2574	2571	2568	2566	2563	2560	2557	2554	2551	2548	6	4
572	2569	2566	2563	2560	2557	2554	2552	2549	2546	2543	2540	2537	2534	7	3
558	2554	2551	2548	2545	2542	2539	2537	2534	2531	2528	2525	2522	2519	8	2
543	2540	2537	2534	2531	2528	2525	2523	2520	2517	2514	2511	2508	2505	9	0
529	2526	2523	2520	2517	2514	2511	2508	2505	2502	2500	2497	2494	2491	S.	Cor.
514	2511	2508	2505	2502	2499	2496	2494	2491	2488	2485	2482	2479	2476	0	13
500	2497	2494	2491	2488	2485	2482	2480	2477	2474	2471	2468	2465	2462	1	12
486	2483	2480	2477	2474	2471	2468	2465	2462	2459	2457	2454	2451	2448	2	10
471	2468	2465	2462	2459	2456	2453	2451	2448	2445	2443	2440	2437	2434	3	9
457	2454	2451	2448	2445	2442	2439	2437	2434	2431	2428	2425	2422	2419	4	7
443	2440	2437	2434	2431	2428	2425	2423	2420	2417	2414	2411	2408	2405	5	6
429	2426	2423	2420	2417	2414	2411	2409	2406	2403	2400	2397	2394	2391	6	5
415	2412	2409	2406	2403	2400	2397	2395	2392	2389	2386	2383	2380	2377	7	3
401	2398	2395	2392	2389	2386	2383	2381	2378	2375	2372	2369	2366	2363	8	2
387	2384	2381	2378	2375	2372	2369	2367	2364	2361	2358	2355	2352	2349	9	0
373	2370	2367	2364	2361	2358	2355	2353	2350	2347	2344	2341	2338	2335	S.	Cor.
359	2356	2353	2350	2347	2344	2341	2339	2336	2333	2331	2328	2325	2322	0	13
345	2342	2339	2336	2333	2330	2327	2325	2322	2319	2317	2314	2311	2308	1	12
331	2304	2301	2298	2295	2292	2289	2287	2284	2281	2278	2275	2272	2269	2	10
317	2290	2287	2284	2281	2278	2275	2273	2270	2267	2264	2261	2258	2255	3	9
303	2286	2283	2280	2277	2274	2271	2269	2266	2263	2260	2257	2254	2251	4	8
289	2282	2279	2276	2273	2270	2267	2265	2262	2259	2256	2253	2250	2247	5	6
275	2278	2275	2272	2269	2266	2263	2261	2258	2255	2252	2249	2246	2243	6	5
261	2274	2271	2268	2265	2262	2259	2257	2254	2251	2248	2245	2242	2239	7	4
247	2270	2267	2264	2261	2258	2255	2253	2250	2247	2244	2241	2238	2235	8	2
233	2266	2263	2260	2257	2254	2251	2249	2246	2243	2240	2237	2234	2231	9	1
219	2262	2259	2256	2253	2250	2247	2245	2242	2239	2236	2233	2230	2227	0	13
205	2258	2255	2252	2249	2246	2243	2241	2238	2235	2232	2229	2226	2223	1	12
191	2254	2251	2248	2245	2242	2239	2237	2234	2231	2228	2225	2222	2219	2	10
177	2250	2247	2244	2241	2238	2235	2233	2230	2227	2224	2221	2218	2215	3	9
163	2246	2243	2240	2237	2234	2231	2229	2226	2223	2220	2217	2214	2211	4	8
149	2242	2239	2236	2233	2230	2227	2225	2222	2219	2216	2213	2210	2207	5	6
135	2238	2235	2232	2229	2226	2223	2221	2218	2215	2212	2209	2206	2203	6	5
121	2234	2231	2228	2225	2222	2219	2217	2214	2211	2208	2205	2202	2199	7	4
107	2230	2227	2224	2221	2218	2215	2213	2210	2207	2204	2201	2198	2195	8	2
93	2226	2223	2220	2217	2214	2211	2209	2206	2203	2200	2197	2194	2191	9	1
79	2222	2219	2216	2213	2210	2207	2205	2202	2199	2196	2193	2190	2187	0	13
65	2218	2215	2212	2209	2206	2203	2201	2198	2195	2192	2189	2186	2183	1	12
51	2214	2211	2208	2205	2202	2199	2197	2194	2191	2188	2185	2182	2179	2	10
37	2210	2207	2204	2201	2198	2195	2193	2190	2187	2184	2181	2178	2175	3	9
23	2206	2203	2200	2197	2194	2191	2189	2186	2183	2180	2177	2174	2171	4	8
9	2202	2199	2196	2193	2190	2187	2185	2182	2179	2176	2173	2170	2167	5	6
	2198	2195	2192	2189	2186	2183	2181	2178	2175	2172	2169	2166	2163	6	5
	2194	2191	2188	2185	2182	2179	2177	2174	2171	2168	2165	2162	2159	7	4
	2190	2187	2184	2181	2178	2175	2173	2170	2167	2164	2161	2158	2155	8	2
	2186	2183	2180	2177	2174	2171	2169	2166	2163	2160	2157	2154	2151	9	1
	2182	2179	2176	2173	2170	2167	2165	2162	2159	2156	2153	2150	2147	0	13
	2178	2175	2172	2169	2166	2163	2161	2158	2155	2152	2149	2146	2143	1	12
	2174	2171	2168	2165	2162	2159	2157	2154	2151	2148	2145	2142	2139	2	10
	2170	2167	2164	2161	2158	2155	2153	2150	2147	2144	2141	2138	2135	3	9
	2166	2163	2160	2157	2154	2151	2149	2146	2143	2140	2137	2134	2131	4	8
	2162	2159	2156	2153	2150	2147	2145	2142	2139	2136	2133	2130	2127	5	6
	2158	2155	2152	2149	2146	2143	2141	2138	2135	2132	2129	2126	2123	6	5
	2154	2151	2148	2145	2142	2139	2137	2134	2131	2128	2125	2122	2119	7	4
	2150	2147	2144	2141	2138	2135	2133	2130	2127	2124	2121	2118	2115	8	2
	2146	2143	2140	2137	2134	2131	2129	2126	2123	2120	2117	2114	2111	9	1
	2142	2139	2136	2133	2130	2127	2125	2122	2119	2116	2113	2110	2107	0	13
	2138	2135	2132	2129	2126	2123	2121	2118	2115	2112	2109	2106	2103	1	12
	2134	2131	2128	2125	2122	2119	2117	2114	2111	2108	2105	2102	2099	2	10
	2130	2127	2124	2121	2118	2115	2113	2110	2107	2104	2101	2098	2095	3	9
	2126	2123	2120	2117	2114	2111	2109	2106	2103	2100	2097	2094	2091	4	8
	2122	2119	2116	2113	2110	2107	2105	2102	2099	2096	2093	2090	2087	5	6
	2118	2115	2112	2109	2106	2103	2101	2098	2095	2092	2089	2086	2083	6	5
	2114	2111	2108	2105	2102	2099	2097	2094	2091	2088	2085	2082	2079	7	4
	2110	2107	2104	2101	2098	2095	2093	2090	2087	2084	2081	2078	2075	8	2
	2106	2103	2100	2097	2094	2091	2089	2086	2083	2080	2077	2074	2071	9	1
	2102	2099	2096	2093	2090	2087	2085	2082	2079	2076	2073	2070	2067	0	13
	2098	2095	2092	2089	2086	2083	2081	2078	2075	2072	2069	2066	2063	1	12
	2094	2091	2088	2085	2082	2079	2077	2074	2071	2068	2065	2062	2059		

TABLE XIX.

CORRELATION.

TABLE A Proportional part for Seconds of Parallax Add											Tab. B For M Add.																		
App. alt. D M	54	55	56	57	58	59	60	61	S	1	2	3	4	5	6	7	8	9	M S										
10	20	10	38	9	39	8	40	7	41	6	41	5	42	4	43	3	44	0	108	57	56	55	54	53	52	51	50	19	
	30	10	35	9	36	8	37	7	38	6	39	5	40	4	41	3	42	0	10	48	47	46	45	44	43	42	41	19	
	40	10	32	9	33	8	34	7	35	6	36	5	37	4	38	3	39	0	20	18	17	16	15	14	13	12	11	29	
	50	10	29	9	30	8	31	7	32	6	33	5	34	4	35	3	36	0	30	29	28	27	26	25	24	23	22	20	
11	0	10	27	9	28	8	29	7	30	6	31	5	32	4	33	3	34	0	40	19	18	17	16	15	14	13	12	10	
	10	10	24	9	25	8	26	7	27	6	28	5	29	4	30	3	31	0	50	9	8	7	6	5	4	3	2	1	0

TABLE XIX LOGARITHMS																		
App. alt. D M	54	55	56	57	58	59	60	61	S	1	2	3	4	5	6	7	8	9
10	20	10	38	9	39	8	40	7	41	6	41	5	42	4	43	3	44	0
	30	10	35	9	36	8	37	7	38	6	39	5	40	4	41	3	42	0
	40	10	32	9	33	8	34	7	35	6	36	5	37	4	38	3	39	0
	50	10	29	9	30	8	31	7	32	6	33	5	34	4	35	3	36	0
11	0	10	27	9	28	8	29	7	30	6	31	5	32	4	33	3	34	0
	10	10	24	9	25	8	26	7	27	6	28	5	29	4	30	3	31	0

TABLE C. Cor for Seconds of Parallax. Add												
App. alt. D M	54	55	56	57	58	59	60	61	S	Cor.		
10	20	10	38	9	39	8	40	7	41	6	0	13
	30	10	35	9	36	8	37	7	38	6	1	12
	40	10	32	9	33	8	34	7	35	6	2	10
	50	10	29	9	30	8	31	7	32	6	3	9
11	0	10	27	9	28	8	29	7	30	6	4	7
	10	10	24	9	25	8	26	7	27	6	5	6
											6	4
											7	3
											8	2
											9	0
											S	Cor.
10	20	10	38	9	39	8	40	7	41	6	0	13
	30	10	35	9	36	8	37	7	38	6	1	12
	40	10	32	9</								

TABLE XIX.

J's Horizontal Parallax								TABLE A. Proportional part for Seconds of Parallax. Add.											Tab. B For M of alt. Add.	
V	55'	56'	57'	58'	59'	60'	61'	S	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	M	S
25	9 26	8 27	7 28	6 30	5 31	4 32	3 33	0	58	57	56	55	54	53	52	51	50	49		
23	9 24	8 25	7 26	6 28	5 29	4 30	3 31	10	48	47	46	45	44	43	42	41	40	39		
21	9 22	8 23	7 24	6 26	5 27	4 28	3 29	20	38	37	36	35	34	33	32	31	30	29		
19	9 20	8 21	7 22	6 24	5 25	4 26	3 27	30	29	28	27	26	25	24	23	22	21	20		
17	9 18	8 19	7 21	6 22	5 23	4 24	3 26	40	19	18	17	16	15	14	13	12	11	10		
15	9 16	8 18	7 19	6 20	5 22	4 23	3 24	50	9	8	7	6	5	4	3	2	1	0		

TABLE XIX. LOGARITHMS																				TABLE C. Cor. for Seconds of Parallax Add.	
Apparent Altitude of γ 's centre.																				S.	Cor.
10	11	15	11	20	11	25	11	30	11	35	11	40	11	45	11	50	11	55	12		
09	2606	2603	2600	2597	2594	2592	2589	2586	2584	2581										0	13
94	2591	2588	2585	2582	2579	2577	2574	2571	2569	2566										1	12
79	2576	2573	2571	2568	2565	2563	2560	2557	2555	2552										2	10
65	2562	2559	2556	2553	2550	2548	2545	2542	2540	2537										3	9
50	2547	2544	2542	2539	2536	2534	2531	2528	2526	2523										4	7
36	2533	2530	2527	2524	2521	2519	2516	2513	2511	2508										5	6
21	2516	2515	2513	2510	2507	2505	2502	2499	2497	2494										6	4
07	2504	2501	2498	2495	2492	2490	2487	2485	2482	2480										7	3
93	2490	2487	2484	2481	2478	2476	2473	2470	2468	2465										8	2
78	2475	2472	2470	2467	2464	2462	2459	2456	2454	2451										9	0
64	2461	2458	2456	2453	2450	2448	2445	2442	2440	2437											
50	2447	2444	2442	2439	2436	2434	2431	2428	2426	2423										S.	Cor.
36	2433	2430	2427	2424	2421	2419	2416	2414	2411	2409										0	13
22	2419	2416	2413	2410	2407	2405	2402	2400	2397	2395										1	12
08	2405	2402	2399	2396	2393	2391	2388	2386	2383	2381										2	10
94	2391	2388	2385	2382	2379	2377	2374	2372	2369	2367										3	9
80	2377	2374	2371	2368	2365	2363	2360	2358	2355	2353										4	7
66	2363	2360	2357	2354	2352	2349	2347	2344	2342	2339										5	6
52	2349	2346	2344	2341	2338	2336	2333	2330	2328	2325										6	5
38	2335	2332	2330	2327	2324	2322	2319	2317	2314	2312										7	3
24	2321	2318	2316	2313	2310	2308	2305	2303	2300	2298										8	2
10	2307	2304	2302	2299	2297	2294	2292	2289	2287	2284										9	0
97	2294	2291	2289	2286	2283	2281	2278	2276	2273	2271										S.	Cor.
83	2280	2277	2275	2272	2269	2267	2264	2262	2259	2257										0	13
69	2266	2263	2261	2258	2256	2253	2251	2248	2246	2243										1	12
56	2253	2250	2248	2245	2242	2240	2237	2235	2232	2230										2	10
42	2239	2236	2234	2231	2229	2226	2224	2221	2219	2216										3	9
29	2226	2223	2221	2218	2216	2213	2210	2208	2205	2203										4	8
15	2212	2209	2207	2204	2202	2199	2197	2195	2192	2190										5	6
02	2199	2196	2194	2191	2189	2186	2184	2181	2179	2176										6	5
89	2186	2183	2181	2178	2175	2173	2170	2168	2165	2163										7	4
75	2172	2169	2167	2164	2162	2159	2157	2155	2152	2150										8	2
62	2159	2156	2154	2151	2149	2146	2144	2141	2139	2136										9	1
49	2146	2143	2141	2138	2135	2133	2130	2128	2125	2123											
36	2133	2130	2128	2125	2122	2120	2117	2115	2112	2110										S.	Cor.
22	2119	2117	2114	2112	2109	2107	2104	2102	2099	2097										0	13
09	2106	2104	2101	2099	2096	2094	2091	2089	2086	2084										1	12
96	2093	2091	2088	2086	2083	2081	2078	2076	2073	2071										2	10
83	2080	2078	2075	2073	2070	2068	2065	2063	2060	2058										3	9
70	2067	2065	2062	2060	2057	2055	2052	2050	2047	2045										4	8
57	2054	2052	2049	2047	2044	2042	2039	2037	2034	2032										5	6
44	2041	2039	2036	2034	2031	2029	2026	2024	2021	2019										6	5
31	2028	2026	2023	2021	2018	2016	2013	2011	2008	2006										7	4
18	2015	2013	2010	2008	2006	2003	2001	1999	1996	1994										8	2
06	2003	2000	1998	1995	1993	1990	1988	1986	1983	1981										9	1
93	1990	1987	1985	1982	1980	1977	1975	1973	1970	1968											

TABLE XIX.

CORRECTION.

App. alt. J's cen- D M	J's Horizontal Parallax.										TABLE A Proportional part for Seconds of Parallax Add										TABLE B Cor for Seconds of Parallax Add.							
	54'	55'	56'	57'	58'	59'	60'	61'	S	0'	1'	2'	3'	4'	5	6	7'	8'	9'	0	1							
12	0	10	16	9	17	8	19	7	20	6	21	5	23	4	24	3	25	0	58	57	56	55	54	53	52	51	50	49
	10	10	15	9	16	8	17	7	19	6	20	5	21	4	23	3	24	10	47	46	45	44	43	42	41	40	39	
	20	10	13	9	14	8	16	7	17	6	19	5	20	4	21	3	23	20	36	37	37	36	35	34	33	32	31	30
	30	10	12	9	13	8	15	7	16	6	17	5	19	4	20	3	22	30	29	28	27	26	25	24	23	22	21	20
	40	10	10	9	12	8	13	7	15	6	16	5	18	4	19	3	21	40	19	18	17	16	15	14	13	12	11	10
	50	10	9	9	11	8	12	7	14	6	15	5	17	4	18	3	20	50	9	8	7	6	5	4	3	2	1	0

TABLE XIX LOGARITHMS												TABLE C. Cor for Seconds of Parallax. Add.	
J's Hor. Parallax.	Apparent Altitude of J's centre										S.	Cor.	
	M	S	12	13	14	15	16	17	18	19			
64	0	2578	2576	2573	2571	2568	2566	2564	2561	2559	2557	2554	
	10	2561	2561	2559	2556	2554	2551	2549	2546	2544	2542	2540	
	20	2544	2544	2542	2540	2537	2535	2532	2530	2528	2525	2523	
	30	2524	2524	2522	2520	2517	2515	2513	2511	2509	2506	2504	
	40	2506	2506	2504	2502	2500	2497	2495	2493	2491	2488	2486	
	50	2488	2488	2486	2484	2482	2479	2477	2474	2472	2470	2468	
55	0	2477	2477	2475	2473	2470	2468	2466	2463	2461	2459	2456	
	10	2461	2461	2459	2457	2454	2452	2450	2447	2445	2443	2441	
	20	2444	2444	2442	2440	2437	2435	2433	2430	2428	2425	2423	
	30	2425	2425	2423	2421	2418	2416	2414	2411	2409	2406	2404	
	40	2406	2406	2404	2402	2400	2397	2395	2393	2391	2388	2386	
	50	2386	2386	2384	2382	2380	2377	2375	2373	2370	2368	2366	
36	0	2366	2366	2364	2362	2360	2357	2355	2353	2351	2348	2346	
	10	2346	2346	2344	2342	2340	2337	2335	2333	2330	2328	2326	
	20	2327	2327	2325	2323	2320	2318	2316	2314	2311	2309	2307	
	30	2307	2307	2305	2303	2301	2298	2296	2294	2291	2289	2287	
	40	2287	2287	2285	2283	2281	2278	2276	2274	2271	2269	2267	
	50	2267	2267	2265	2263	2261	2258	2256	2254	2251	2249	2247	
57	0	2247	2247	2245	2243	2240	2238	2236	2233	2231	2229	2227	
	10	2227	2227	2225	2223	2221	2218	2216	2214	2211	2209	2207	
	20	2207	2207	2205	2203	2201	2198	2196	2194	2191	2189	2187	
	30	2187	2187	2185	2183	2181	2178	2176	2174	2171	2169	2167	
	40	2167	2167	2165	2163	2161	2158	2156	2154	2151	2149	2147	
	50	2147	2147	2145	2143	2141	2138	2136	2134	2131	2129	2127	
58	0	2127	2127	2125	2123	2121	2118	2116	2114	2111	2109	2107	
	10	2107	2107	2105	2103	2101	2098	2096	2094	2091	2089	2087	
	20	2087	2087	2085	2083	2081	2078	2076	2074	2071	2069	2067	
	30	2067	2067	2065	2063	2061	2058	2056	2054	2051	2049	2047	
	40	2047	2047	2045	2043	2041	2038	2036	2034	2031	2029	2027	
	50	2027	2027	2025	2023	2021	2018	2016	2014	2011	2009	2007	
59	0	2007	2007	2005	2003	2001	1998	1996	1994	1991	1989	1987	
	10	1987	1987	1985	1983	1981	1978	1976	1974	1971	1969	1967	
	20	1967	1967	1965	1963	1961	1958	1956	1954	1951	1949	1947	
	30	1947	1947	1945	1943	1941	1938	1936	1934	1931	1929	1927	
	40	1927	1927	1925	1923	1921	1918	1916	1914	1911	1909	1907	
	50	1907	1907	1905	1903	1901	1898	1896	1894	1891	1889	1887	
60	0	1887	1887	1885	1883	1881	1878	1876	1874	1871	1869	1867	
	10	1867	1867	1865	1863	1861	1858	1856	1854	1851	1849	1847	
	20	1847	1847	1845	1843	1841	1838	1836	1834	1831	1829	1827	
	30	1827	1827	1825	1823	1821	1818	1816	1814	1811	1809	1807	
	40	1807	1807	1805	1803	1801	1798	1796	1794	1791	1789	1787	
	50	1787	1787	1785	1783	1781	1778	1776	1774	1771	1769	1767	
61	0	1767	1767	1765	1763	1761	1758	1756	1754	1751	1749	1747	
	10	1747	1747	1745	1743	1741	1738	1736	1734	1731	1729	1727	
	20	1727	1727	1725	1723	1721	1718	1716	1714	1711	1709	1707	
	30	1707	1707	1705	1703	1701	1698	1696	1694	1691	1689	1687	
	40	1687	1687	1685	1683	1681	1678	1676	1674	1671	1669	1667	
	50	1667	1667	1665	1663	1661	1658	1656	1654	1651	1649	1647	

99

Tab. B
For M
not ak.
Add.

[illegible]

TABLE C
Cor for Seconds
of Parallax
Add

Apparent Altitude of γ 's centre.													TABLE C Cor for Seconds of Parallax Add	
0	1	2	3	4	5	6	7	8	9	10	11	12	S.	Cor.
0	13	10	8	6	5	4	3	2	1	0	0	0	0	0
1	13	10	8	6	5	4	3	2	1	0	0	0	0	0
2	13	10	8	6	5	4	3	2	1	0	0	0	0	0
3	13	10	8	6	5	4	3	2	1	0	0	0	0	0
4	13	10	8	6	5	4	3	2	1	0	0	0	0	0
5	13	10	8	6	5	4	3	2	1	0	0	0	0	0
6	13	10	8	6	5	4	3	2	1	0	0	0	0	0
7	13	10	8	6	5	4	3	2	1	0	0	0	0	0
8	13	10	8	6	5	4	3	2	1	0	0	0	0	0
9	13	10	8	6	5	4	3	2	1	0	0	0	0	0
10	13	10	8	6	5	4	3	2	1	0	0	0	0	0
11	13	10	8	6	5	4	3	2	1	0	0	0	0	0
12	13	10	8	6	5	4	3	2	1	0	0	0	0	0
13	13	10	8	6	5	4	3	2	1	0	0	0	0	0
14	13	10	8	6	5	4	3	2	1	0	0	0	0	0
15	13	10	8	6	5	4	3	2	1	0	0	0	0	0
16	13	10	8	6	5	4	3	2	1	0	0	0	0	0
17	13	10	8	6	5	4	3	2	1	0	0	0	0	0
18	13	10	8	6	5	4	3	2	1	0	0	0	0	0
19	13	10	8	6	5	4	3	2	1	0	0	0	0	0
20	13	10	8	6	5	4	3	2	1	0	0	0	0	0
21	13	10	8	6	5	4	3	2	1	0	0	0	0	0
22	13	10	8	6	5	4	3	2	1	0	0	0	0	0
23	13	10	8	6	5	4	3	2	1	0	0	0	0	0
24	13	10	8	6	5	4	3	2	1	0	0	0	0	0
25	13	10	8	6	5	4	3	2	1	0	0	0	0	0
26	13	10	8	6	5	4	3	2	1	0	0	0	0	0
27	13	10	8	6	5	4	3	2	1	0	0	0	0	0
28	13	10	8	6	5	4	3	2	1	0	0	0	0	0
29	13	10	8	6	5	4	3	2	1	0	0	0	0	0
30	13	10	8	6	5	4	3	2	1	0	0	0	0	0
31	13	10	8	6	5	4	3	2	1	0	0	0	0	0
32	13	10	8	6	5	4	3	2	1	0	0	0	0	0
33	13	10	8	6	5	4	3	2	1	0	0	0	0	0
34	13	10	8	6	5	4	3	2	1	0	0	0	0	0
35	13	10	8	6	5	4	3	2	1	0	0	0	0	0
36	13	10	8	6	5	4	3	2	1	0	0	0	0	0
37	13	10	8	6	5	4	3	2	1	0	0	0	0	0
38	13	10	8	6	5	4	3	2	1	0	0	0	0	0
39	13	10	8	6	5	4	3	2	1	0	0	0	0	0
40	13</													

TABLE XIX

CORRECTION.

App. alt. D's cos		D's Horizontal Parallax.										TABLE A Proportional part for Seconds of Parallax. Add										Tab B For M of alt. Add																																																																						
D	M	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																								
14	0	10	69	88	97	116	135	154	173	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	10	10	69	78	97	116	135	154	163	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	20	10	69	78	97	116	135	144	163	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	30	10	69	78	97	116	135	144	163	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	40	10	69	78	97	116	135	154	163	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	50	10	69	78	97	116	134	154	173	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

TABLE XIX. LOGARITHMS.

N. H. or Parallax	Apparent Altitude of β 's centre																				TABLE C Cor for Seconds of Parallax. Add																												
																					S	Cor																											
14	0 14	0 14	5 14	10 14	15 14	20 14	25 14	30 14	35 14	40 14	45 14	50 14	55 14	0 15	5 15	10 15	15 15	20 15	25 15	30 15	35 15	40 15	45 15	50 15	55 15	0 16	5 16	10 16	15 16	20 16	25 16	30 16	35 16	40 16	45 16	50 16	55 16	0 17	5 17	10 17	15 17	20 17	25 17	30 17	35 17	40 17	45 17	50 17	55 17
15	0 15	5 15	10 15	15 15	20 15	25 15	30 15	35 15	40 15	45 15	50 15	55 15	0 16	5 16	10 16	15 16	20 16	25 16	30 16	35 16	40 16	45 16	50 16	55 16	0 17	5 17	10 17	15 17	20 17	25 17	30 17	35 17	40 17	45 17	50 17	55 17	0 18	5 18	10 18	15 18	20 18	25 18	30 18	35 18	40 18	45 18	50 18	55 18	
16	0 16	5 16	10 16	15 16	20 16	25 16	30 16	35 16	40 16	45 16	50 16	55 16	0 17	5 17	10 17	15 17	20 17	25 17	30 17	35 17	40 17	45 17	50 17	55 17	0 18	5 18	10 18	15 18	20 18	25 18	30 18	35 18	40 18	45 18	50 18	55 18	0 19	5 19	10 19	15 19	20 19	25 19	30 19	35 19	40 19	45 19	50 19	55 19	
17	0 17	5 17	10 17	15 17	20 17	25 17	30 17	35 17	40 17	45 17	50 17	55 17	0 18	5 18	10 18	15 18	20 18	25 18	30 18	35 18	40 18	45 18	50 18	55 18	0 19	5 19	10 19	15 19	20 19	25 19	30 19	35 19	40 19	45 19	50 19	55 19	0 20	5 20	10 20	15 20	20 20	25 20	30 20	35 20	40 20	45 20	50 20	55 20	
18	0 18	5 18	10 18	15 18	20 18	25 18	30 18	35 18	40 18	45 18	50 18	55 18	0 19	5 19	10 19	15 19	20 19	25 19	30 19	35 19	40 19	45 19	50 19	55 19	0 20	5 20	10 20	15 20	20 20	25 20	30 20	35 20	40 20	45 20	50 20	55 20	0 21	5 21	10 21	15 21	20 21	25 21	30 21	35 21	40 21	45 21	50 21	55 21	
19	0 19	5 19	10 19	15 19	20 19	25 19	30 19	35 19	40 19	45 19	50 19	55 19	0 20	5 20	10 20	15 20	20 20	25 20	30 20	35 20	40 20	45 20	50 20	55 20	0 21	5 21	10 21	15 21	20 21	25 21	30 21	35 21	40 21	45 21	50 21	55 21	0 22	5 22	10 22	15 22	20 22	25 22	30 22	35 22	40 22	45 22	50 22	55 22	
20	0 20	5 20	10 20	15 20	20 20	25 20	30 20	35 20	40 20	45 20	50 20	55 20	0 21	5 21	10 21	15 21	20 21	25 21	30 21	35 21	40 21	45 21	50 21	55 21	0 22	5 22	10 22	15 22	20 22	25 22	30 22	35 22	40 22	45 22	50 22	55 22	0 23	5 23	10 23	15 23	20 23	25 23	30 23	35 23	40 23	45 23	50 23	55 23	

TABLE XIX. CORRECTION.

101

J's Horizontal Parallax.								TABLE A. Prop. part for Sec of Paral Add												TABLE B. For Miles of alt Add				
55'	56'	57'	58'	59'	60'	61'		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	M	S
59	78	97	116	135	154	173	19	0	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	0
59	78	97	116	135	154	173	19	10	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	0
59	78	97	116	135	154	173	20	20	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	0
59	78	107	126	145	164	183	20	30	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	0
69	8	107	126	145	164	183	21	40	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	0
69	8	107	136	155	174	193	22	50	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	0
69	8	117	136	155	174	193	23	0	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	0
79	18	127	146	165	184	203	24	10	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	0
79	18	127	156	175	194	213	24	20	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	0
89	118	137	156	175	194	213	25	30	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	0
99	118	147	166	185	204	223	26	40	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	0
109	128	157	176	195	214	233	27	50	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	0

TABLE XIX LOGARITHMS.													TABLE C										
Apparent Altitude of ☉ & centre													Cor for Sec of Par Add										
15	10	15	30	15	30	15	30	15	30	16	0	15	10	15	30	16	30	16	40	16	50	S	Cor
2503	2500	2497	2494	2491	2488	2495	2492	2489	2486	2483	2480	2477	2474	2471	2468	2465	2462	2459	2456	2453	2450	0	13
2488	2485	2482	2479	2476	2473	2470	2467	2464	2461	2458	2455	2452	2449	2446	2443	2440	2437	2434	2431	2428	2425	1	12
2474	2471	2468	2465	2462	2459	2456	2453	2450	2447	2444	2441	2438	2435	2432	2429	2426	2423	2420	2417	2414	2411	2	10
2460	2457	2454	2451	2448	2445	2442	2439	2436	2433	2430	2427	2424	2421	2418	2415	2412	2409	2406	2403	2400	2397	3	9
2446	2443	2440	2437	2434	2431	2428	2425	2422	2419	2416	2413	2410	2407	2404	2401	2398	2395	2392	2389	2386	2383	4	7
2432	2429	2426	2423	2420	2417	2414	2411	2408	2405	2402	2399	2396	2393	2390	2387	2384	2381	2378	2375	2372	2369	5	6
2418	2415	2412	2409	2406	2403	2400	2397	2394	2391	2388	2385	2382	2379	2376	2373	2370	2367	2364	2361	2358	2355	6	5
2404	2401	2398	2395	2392	2389	2386	2383	2380	2377	2374	2371	2368	2365	2362	2359	2356	2353	2350	2347	2344	2341	7	3
2390	2387	2384	2381	2378	2375	2372	2369	2366	2363	2360	2357	2354	2351	2348	2345	2342	2339	2336	2333	2330	2327	8	2
2376	2373	2370	2367	2364	2361	2358	2355	2352	2349	2346	2343	2340	2337	2334	2331	2328	2325	2322	2319	2316	2313	9	0
2362	2359	2356	2353	2350	2347	2344	2341	2338	2335	2332	2329	2326	2323	2320	2317	2314	2311	2308	2305	2302	2299		
2348	2345	2342	2339	2336	2333	2330	2327	2324	2321	2318	2315	2312	2309	2306	2303	2300	2297	2294	2291	2288	2285	S	Cor
2334	2331	2328	2325	2322	2319	2316	2313	2310	2307	2304	2301	2298	2295	2292	2289	2286	2283	2280	2277	2274	2271	0	13
2320	2317	2314	2311	2308	2305	2302	2299	2296	2293	2290	2287	2284	2281	2278	2275	2272	2269	2266	2263	2260	2257	1	12
2307	2304	2301	2298	2295	2292	2289	2286	2283	2280	2277	2274	2271	2268	2265	2262	2259	2256	2253	2250	2247	2244	2	10
2293	2290	2287	2284	2281	2278	2275	2272	2269	2266	2263	2260	2257	2254	2251	2248	2245	2242	2239	2236	2233	2230	3	9
2279	2276	2273	2270	2267	2264	2261	2258	2255	2252	2249	2246	2243	2240	2237	2234	2231	2228	2225	2222	2219	2216	4	8
2265	2262	2259	2256	2253	2250	2247	2244	2241	2238	2235	2232	2229	2226	2223	2220	2217	2214	2211					

TABLE XIX. CORRECTION.

Table A											Table B								
Horizontal Parallax.											Prop part for Sec. of Paral. Add		Tab. B For Miles of alt. Add						
M	S	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	M	S
17	0	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
17	10	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
17	20	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
17	30	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
17	40	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
17	50	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	0	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	10	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	20	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	30	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	40	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0
18	50	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0

TABLE XIX. CORRECTION.

103

Ap alt cent.	Sun's Horizontal Parallax,										TABLE A. Prop. part for Sec. of Paral. Add												Tab. B. For Miles of Alt. Add.	
	D	M	54'	55'	56'	57'	58'	59'	60'	61'	S	0	1	2	3	4	5	6	7	8	9	M	S	
19	0	10	26.9	29.8	32.7	35.6	38.5	41.4	44.3	47.2	0	56	53	54	53	52	51	50	49	48	47	4	0	
	10	10	28.9	31.8	34.7	37.6	40.5	43.4	46.3	49.2	10	47	46	45	44	43	42	41	40	39	38	3	0	
	20	10	29.9	33.8	36.7	39.6	42.5	45.4	48.3	51.2	20	37	36	35	34	33	32	31	30	29	28	2	0	
	30	10	31.9	34.8	37.7	40.6	43.5	46.4	49.3	52.2	30	27	26	25	24	23	22	21	20	19	18	1	0	
	40	10	33.9	36.8	39.7	42.6	45.5	48.4	51.3	54.2	40	17	16	15	14	13	12	11	10	9	8	0	0	
	50	10	34.9	38.8	41.7	44.6	47.5	50.4	53.3	56.2	50	7	6	5	4	3	2	1	0	0	0	0	0	
20	0	10	37.9	41.8	44.7	47.6	50.5	53.4	56.3	59.2	0	55	54	53	52	51	50	49	48	47	46	0	0	
	10	10	39.9	43.8	46.7	49.6	52.5	55.4	58.3	61.2	10	45	44	43	42	41	40	39	38	37	36	0	0	
	20	10	41.9	45.8	48.7	51.6	54.5	57.4	60.3	63.2	20	35	34	33	32	31	30	29	28	27	26	0	0	
	30	10	43.9	47.8	50.7	53.6	56.5	59.4	62.3	65.2	30	25	24	23	22	21	20	19	18	17	16	0	0	
	40	10	45.9	49.8	52.7	55.6	58.5	61.4	64.3	67.2	40	15	14	13	12	11	10	9	8	7	6	0	0	
	50	10	47.9	51.8	54.7	57.6	60.5	63.4	66.3	69.2	50	5	4	3	2	1	0	0	0	0	0	0	0	

Hor. Paral	TABLE XIX LOGARITHMS Apparent Altitude of Sun's centre									
	S	10	19	10	19	20	19	30	19	50
54	0	2445	2443	2441	2439	2437	2435	2433	2431	2429
	10	2430	2427	2425	2423	2421	2419	2417	2415	2413
	20	2410	2407	2405	2403	2401	2399	2397	2395	2393
	30	2402	2399	2397	2395	2393	2391	2389	2387	2385
	40	2395	2392	2390	2388	2386	2384	2382	2380	2378
	50	2371	2368	2366	2364	2362	2360	2358	2356	2354
55	0	2360	2357	2355	2353	2351	2349	2347	2345	2343
	10	2347	2344	2342	2340	2338	2336	2334	2332	2330
	20	2333	2331	2329	2327	2325	2323	2321	2319	2317
	30	2319	2317	2315	2313	2311	2309	2307	2305	2303
	40	2305	2303	2301	2299	2297	2295	2293	2291	2289
	50	2292	2290	2288	2286	2284	2282	2280	2278	2276
56	0	2273	2271	2269	2267	2265	2263	2261	2259	2257
	10	2259	2257	2255	2253	2251	2249	2247	2245	2243
	20	2245	2243	2241	2239	2237	2235	2233	2231	2229
	30	2237	2235	2233	2231	2229	2227	2225	2223	2221
	40	2224	2222	2220	2218	2216	2214	2212	2210	2208
	50	2210	2208	2206	2204	2202	2200	2198	2196	2194
57	0	2197	2195	2193	2191	2189	2187	2185	2183	2181
	10	2184	2182	2180	2178	2176	2174	2172	2170	2168
	20	2170	2168	2166	2164	2162	2160	2158	2156	2154
	30	2157	2155	2153	2151	2149	2147	2145	2143	2141
	40	2144	2142	2140	2138	2136	2134	2132	2130	2128
	50	2130	2128	2126	2124	2122	2120	2118	2116	2114
58	0	2117	2115	2113	2111	2109	2107	2105	2103	2101
	10	2104	2102	2100	2098	2096	2094	2092	2090	2088
	20	2091	2089	2087	2085	2083	2081	2079	2077	2075
	30	2077	2075	2073	2071	2069	2067	2065	2063	2061
	40	2068	2066	2064	2062	2060	2058	2056	2054	2052
	50	2052	2050	2048	2046	2044	2042	2040	2038	2036
59	0	2033	2031	2029	2027	2025	2023	2021	2019	2017
	10	2026	2024	2022	2020	2018	2016	2014	2012	2010
	20	2014	2012	2010	2008	2006	2004	2002	2000	1998
	30	1997	1995	1993	1991	1989	1987	1985	1983	1981
	40	1988	1986	1984	1982	1980	1978	1976	1974	1972
	50	1975	1973	1971	1969	1967	1965	1963	1961	1959
60	0	1956	1954	1952	1950	1948	1946	1944	1942	1940
	10	1947	1945	1943	1941	1939	1937	1935	1933	1931
	20	1937	1935	1933	1931	1929	1927	1925	1923	1921
	30	1925	1923	1921	1919	1917	1915	1913	1911	1909
	40	1912	1910	1908	1906	1904	1902	1900	1898	1896
	50	1899	1897	1895	1893	1891	1889	1887	1885	1883
61	0	1879	1877	1875	1873	1871	1869	1867	1865	1863
	10	1864	1862	1860	1858	1856	1854	1852	1850	1848
	20	1850	1848	1846	1844	1842	1840	1838	1836	1834
	30	1835	1833	1831	1829	1827	1825	1823	1821	1819

TABLE C. Cor for Sec of Par Add	
S.	Cor.
0	12
1	11
2	9
3	8
4	6
5	5
6	4
7	2
8	1
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0
S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

CORRECTION.

App. alt. D. M.	Moon's Horizontal Parallax.										TABLE A Prop part for Seconds of Paral Add.										Tab. B For M. of alt. Add.	
	54'	55'	56'	57'	58'	59'	60'	61'			5	6	7	8	9	10	11	12	13	14	M	S
21	0 10 4	9 53	8 57.8	17	5.6	9.5	13.4	17	0 55.54	53.52	51	50	49	48	47							
	10 10 51	9 55	8 59.8	37.	7.6	11.5	15.4	19	10 46 45	44.43	42	41	40	39	38							
	20 10 53	9 57	9 1.8	67	10.6	14.5	18.4	22	20 36 35	35.34	33	32	31	30	29							
	30 10 55 10	0 9.	4.8	87	12.6	16.5	20.4	25	30 27 26	25.24	23	22	21	20	19							
	40 10 58 10	2 9.	6.8	107	15.6	19.5	23.4	27	40 18 17	16.15	14	13	12	11	10							
	50 11 0 10	4 9	9.8	137	17.6	22.5	26.4	30	50 8 8	7.6	5	4	3	2	1	0						
22	0 11 2 10	7 9	11.8	167	20.6	24.5	29.4	33	0 55 54	53.52	51	50	49	48	47							
	10 11 5 10.	9 9	14.8	187	22.6	27.5	31.4	36	10 46 45	44.43	42	41	40	39	38							
	20 11 7 10 12	9 16.8	21.7	23.6	30.5	34.4	39	20 37 36	35.34	33	32	31	30	29	28							
	30 11 10 10 14	9 19.8	23.7	29.6	32.5	37.4	42	30 27 26	25.25	24	23	22	21	20	19							
	40 11 12 10 17	9 21.8	26.7	31.6	35.5	40.4	45	40 18 17	16.15	14	13	12	11	10	9							
	50 11 15 10 19	9 24.6	29.7	34.6	38.5	43.4	48	50 9 8	7.6	5	4	3	2	1	0							
23	0 11 18 10 23	9 28.2	33.7	37.6	42.5	47.4	52	0 54 53	52.51	50	49	48	47	46								
	10 11 21 10. 26	9 31.8	35.7	40.6	44.5	50.4	55	10 45 44	43.42	41	40	39	38	37	36							
	20 11 24 10 29	9 35.8	38.7	43.6	48.5	53.4	58	20 36 35	34.33	32	31	30	29	28	27							
	30 11 26 10 31	9 36.8	41.7	46.6	51.5	56.5	1	30 26 26	25.24	23	22	21	20	19	18							
	40 11 29 10 34	9 39.8	44.7	49.6	54.5	59.5	4	40 17 16	15.15	14	13	12	11	10	9							
	50 11 32 10 37	9 42.8	47.7	52.6	57.6	62.6	8	50 8 8	7.6	5	4	3	2	1	0							
24	0 11 35 10 40	9 45.8	50.7	55.7	1.6	6.5	11	0 54 53	52.51	50	49	48	47	46								
	10 11 38 10 43	9 48.8	53.7	58.7	4.6	9.5	14	10 45 44	43.42	41	40	39	38	37								
	20 11 40 10 46	9 51.8	56.8	61.7	7.6	12.5	18	20 36 35	34.33	32	31	30	29	28								
	30 11 43 10 49	9 54.9	59.8	64.7	10.6	15.5	21	30 27 26	25.24	23	22	21	20	19	18							
	40 11 46 10 52	9 57.9	62.8	67.7	13.6	18.5	25	40 18 17	16.15	14	13	12	11	10	9							
	50 11 49 10 55 10.	0 9	6.8	127	17.6	22.5	28	50 8 8	7.6	5	4	3	2	1	0							

Explanation of Table XIX.

This table consists of two parts, for finding a correction of the moon's distance and a logarithm corresponding they are both in the same page from the beginning of the table to the altitude of 21 degrees, after which the correction is on the left hand page, and the logarithm on the right, both being found at the same opening of the book, in the following manner.

To find the correction of Table XIX.

1. Enter the table marked *Correction*, and find in the side column the moon's apparent altitude, or the altitude next less if there be any units of miles in the altitude; opposite to this and under the minutes of the moon's horizontal parallax will be the approximate correction.

2. Enter table A, abreast of the approximate correction, and find the seconds of the moon's horizontal parallax, viz. the tens of seconds at the side, and the units at the top, under the latter, and opposite the former will be the correction of table A.

3. Enter table B, abreast of the approximate correction, and find the units of miles in the moon's apparent altitude (neglected above) opposite to which will be a number of seconds, which being added to the corrections found from table XIX. and from table A, will give the sought correction.

To find the Logarithm of Table XIX.

Enter the table marked *Logarithms*, in the column titled at the top with the degrees and minutes nearest to the moon's apparent altitude, and find the logarithm corresponding to the moon's horizontal parallax in the side column, or the next less parallax if there be units of seconds in it. Abreast of this in the table C, opposite the units of seconds of parallax neglected, will be a correction, to be added to the former logarithm, to obtain the logarithm sought.

It was observed in a former part of this work that in fixing these tables so as to render the corrections of the tables A, B, C, additive, it had been found necessary to make the greatest corrections correspond to 0' of parallax and 0' of altitude, so that when you find the exact parallax and altitude in the side and top columns of table XIX. it will still be necessary to refer to the tables A, B, or C, to take out the corrections corresponding to 0' of parallax or 0' of altitude. This is evident from the inspection of the tables, but it was proper to make this remark as a caution to prevent mistakes. To illustrate these rules, the following examples are given, in which all the corrections are put down and added together, but after a little practice it will be very easy to take the numbers from the table by inspection, and add them together without the trouble of writing them down separately.

TABLE XIX.

105

LOGARITHMS.

Apparent Altitude of β 's centre.														TABLE C. Cor. for Seconds of Parallax. Add.	
														S.	Cor.
1422	2419	2416	2413	2410	2407	2404	2401	2399	2396	2394	2391	2388	2385	0	12
1409	2405	2402	2399	2396	2393	2390	2387	2385	2382	2380	2377	2374	2371	1	11
2394	2391	2388	2385	2382	2379	2376	2373	2371	2368	2366	2363	2360	2357	2	9
2380	2377	2374	2371	2368	2365	2362	2360	2357	2355	2352	2350	2347	2344	3	8
2366	2363	2360	2357	2354	2352	2349	2346	2344	2341	2339	2336	2333	2330	4	6
2352	2349	2346	2343	2340	2338	2335	2332	2330	2327	2325	2322	2319	2316	5	5
2339	2335	2332	2329	2326	2324	2321	2318	2316	2313	2311	2308	2305	2302	6	4
2325	2322	2319	2316	2313	2310	2307	2304	2302	2299	2297	2294	2291	2288	7	2
2311	2308	2305	2302	2299	2296	2293	2291	2288	2286	2284	2281	2278	2275	8	1
2297	2294	2291	2288	2285	2283	2280	2277	2275	2272	2270	2267	2264	2261	9	0
2284	2281	2278	2275	2272	2269	2266	2263	2261	2258	2256	2253	2250	2247	S.	Cor.
2270	2267	2264	2261	2258	2256	2253	2250	2248	2245	2243	2240	2237	2234	0	12
2257	2253	2250	2247	2244	2242	2239	2236	2234	2231	2229	2226	2223	2220	1	11
2243	2240	2237	2234	2231	2229	2226	2223	2221	2218	2216	2213	2210	2207	2	9
2229	2226	2223	2220	2217	2215	2212	2210	2207	2205	2203	2200	2197	2194	3	8
2216	2213	2210	2207	2204	2202	2199	2196	2194	2191	2189	2186	2183	2180	4	7
2203	2200	2197	2194	2191	2188	2185	2183	2180	2178	2176	2173	2170	2167	5	6
2189	2186	2183	2180	2177	2175	2172	2170	2167	2165	2163	2160	2157	2154	6	4
2176	2173	2170	2167	2164	2162	2159	2156	2154	2151	2149	2146	2143	2140	7	3
2163	2160	2157	2154	2151	2149	2146	2143	2141	2138	2136	2133	2130	2127	8	1
2149	2146	2144	2141	2138	2135	2132	2130	2128	2125	2123	2120	2117	2114	9	0
2136	2133	2130	2127	2124	2122	2119	2117	2115	2112	2110	2107	2104	2101	S.	Cor.
2123	2120	2117	2114	2111	2109	2106	2104	2101	2099	2097	2094	2091	2088	0	12
2110	2107	2104	2101	2098	2096	2093	2091	2088	2086	2084	2081	2078	2075	1	11
2097	2094	2091	2088	2085	2083	2080	2078	2075	2073	2071	2068	2065	2062	2	9
2084	2081	2078	2075	2072	2070	2067	2065	2062	2060	2058	2055	2052	2049	3	8
2071	2068	2065	2062	2059	2057	2054	2052	2049	2047	2045	2042	2039	2036	4	7
2058	2055	2052	2049	2046	2044	2041	2039	2036	2034	2032	2029	2026	2023	5	6
2045	2042	2039	2036	2033	2031	2028	2026	2023	2021	2019	2016	2013	2010	6	4
2032	2029	2026	2023	2020	2018	2015	2013	2010	2008	2006	2003	2000	1998	7	3
2019	2016	2013	2010	2007	2005	2003	2000	1998	1995	1993	1991	1988	1985	8	2
2006	2003	2001	1998	1995	1993	1990	1987	1985	1982	1980	1978	1975	1972	9	0
1993	1990	1988	1985	1982	1980	1977	1975	1972	1970	1968	1965	1962	1959	S.	Cor.
1981	1978	1975	1972	1969	1967	1964	1962	1959	1957	1955	1953	1950	1947	0	12
1968	1965	1962	1959	1957	1954	1952	1949	1947	1944	1942	1940	1937	1934	1	11
1955	1952	1950	1947	1944	1942	1939	1937	1934	1932	1930	1927	1924	1921	2	10
1943	1940	1937	1934	1931	1929	1926	1924	1921	1919	1917	1915	1912	1909	3	8
1930	1927	1925	1922	1919	1917	1914	1912	1909	1907	1905	1902	1900	1897	4	7
1917	1914	1912	1909	1906	1904	1901	1899	1896	1894	1892	1890	1887	1884	5	6
1905	1902	1900	1897	1894	1892	1889	1887	1884	1882	1880	1877	1875	1872	6	5
1892	1889	1887	1884	1881	1879	1876	1874	1871	1869	1867	1865	1862	1859	7	4
1880	1877	1875	1872	1869	1867	1864	1862	1859	1857	1855	1853	1850	1847	8	3
1868	1865	1862	1859	1857	1854	1852	1850	1847	1845	1843	1840	1837	1834	9	2
1855	1852	1850	1847	1844	1842	1839	1837	1834	1832	1830	1828	1825	1822	0	1
1843	1840	1837	1834	1832	1830	1827	1825	1822	1820	1818	1816	1813	1810	S.	Cor.
1831	1828	1825	1822	1820	1817	1815	1813	1810	1808	1806	1803	1800	1798	0	12

TABLE XIX.

CORRECTION.

App. alt D M	°	Moon's Horizontal Parallax										TABLE A. Proportional part for Seconds of Parallax. Add										Tab. E F. M. of alt. Add								
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20												
25	0	11	53	10	52	10	5	9	10	3.16	7	22	6	27	5	33	0	53	52	51	50	49	48	47	46	45	0			
	10	11	57	11	2	10	4	9	11	8	19	7	25	6	31	5	36	10	44	43	42	41	40	39	38	37	36	0		
	20	12	0	11	5	10	11	9	17	8	23	7	28	6	34	5	40	20	33	34	33	32	31	30	29	28	27	0		
	30	12	3	11	9	11	13	9	20	8	26	7	32	6	38	5	44	30	26	25	24	23	22	21	20	19	18	0		
	40	12	6	11	12	10	18	9	24	8	30	7	36	6	41	5	47	40	17	16	15	14	13	12	11	10	9	0		
	50	12	9	11	15	10	21	9	27	8	33	7	39	6	45	5	51	50	8	7	6	5	4	3	2	1	0	0		
26		12	15	11	19	10	25	9	31	8	37	7	43	6	49	5	55	0	53	52	51	50	49	48	47	46	45	0		
	10	12	18	11	22	10	28	9	34	8	40	7	46	6	53	5	59	10	44	43	42	41	40	39	38	37	36	0		
	20	12	19	11	25	10	32	9	38	8	44	7	50	6	56	5	63	20	35	34	33	32	31	30	29	28	27	0		
	30	12	23	11	29	10	36	9	41	8	47	7	54	6	60	5	67	30	26	25	24	23	22	21	20	19	18	0		
	40	12	26	11	32	10	40	9	45	8	51	7	58	6	64	5	71	40	17	16	15	14	13	12	11	10	9	0		
	50	12	29	11	36	10	44	9	49	8	55	7	62	6	68	5	75	50	8	7	6	5	4	3	2	1	0	0		
27	0	12	34	11	40	10	17	9	53	9	0	67	13	6	20	0	52	51	50	49	48	47	46	45	44	43	42	0		
	10	12	37	11	43	10	51	9	57	9	48	10	7	17	6	24	10	43	42	41	40	39	38	37	36	35	34	33	0	
	20	12	41	11	47	10	55	10	1	9	8	8	14	7	21	6	28	20	34	33	32	31	30	29	28	27	26	25	0	
	30	12	44	11	51	10	59	10	5	9	11	8	18	7	25	6	32	30	25	24	23	22	21	20	19	18	17	16	0	
	40	12	47	11	55	10	63	10	9	9	15	8	22	7	29	6	36	40	17	16	15	14	13	12	11	10	9	9	0	
	50	12	52	11	59	10	67	10	13	9	19	8	26	7	33	6	40	50	8	7	6	5	4	3	2	1	0	0	0	
28	0	12	55	11	63	10	17	9	23	9	23	8	30	7	37	6	44	0	52	51	50	49	48	47	46	45	44	43	0	
	10	12	58	11	67	10	21	9	27	9	27	8	34	7	41	6	49	10	43	42	41	40	39	38	37	36	35	34	0	
	20	13	3	12	10	11	17	10	31	9	31	8	38	7	45	6	53	20	34	33	32	31	30	29	28	27	26	25	0	
	30	13	6	12	14	11	21	10	35	9	36	8	42	7	50	6	57	30	26	25	24	23	22	21	20	19	18	17	0	
	40	13	10	12	18	11	25	10	39	9	40	8	46	7	54	6	61	40	17	16	15	14	13	12	11	10	9	9	0	
	50	13	14	12	22	11	29	10	43	9	44	8	51	7	59	6	65	50	8	7	6	5	4	3	2	1	0	0	0	
29	0	13	19	12	26	11	33	10	48	9	49	8	57	8	47	12	0	51	50	49	48	47	46	45	44	43	42	41	0	
	10	13	23	12	30	11	37	10	46	9	53	9	1	8	37	16	10	10	42	41	40	39	38	37	36	35	34	33	32	0
	20	13	27	12	34	11	41	10	50	9	57	9	5	8	13	21	20	34	33	32	31	30	29	28	27	26	25	24	23	0
	30	13	31	12	38	11	45	10	54	10	29	10	8	17	7	25	30	25	24	23	22	21	20	19	18	17	16	15	14	0
	40	13	35	12	43	11	50	10	58	10	33	10	11	8	22	30	40	16	15	14	13	12	11	10	9	8	7	6	5	0
	50	13	39	12	47	11	55	11	3	10	37	10	15	8	26	34	50	7	7	6	5	4	3	2	1	0	0	0	0	0

EXAMPLE I.

Given the moon's apparent altitude $44^{\circ} 27'$, and her horizontal parallax $56' 55''$. Required the correction and logarithm.

For the Correction.		For the Logarithm.	
In Tab. xix to alt. $44^{\circ} 20'$ and p. $56'$ is $19' 31''$		In Tab. xix to nearest alt. 44° and par. $56' 50''$ is	
.. Tab. A $56'$ parallax	3	.. Tab. C $56'$ parallax	5
.. Tab. B $7'$ altitude	5	Sought logarithm	2382
Sought correction	$20' 0''$		

EXAMPLE II.

Given the moon's apparent altitude $50^{\circ} 16'$, and horizontal parallax $59' 0''$. Required the correction and logarithm.

For the Correction.		For the Logarithm.	
In Tab. xix to alt. $50^{\circ} 10'$ and par. $59'$ is $22' 3''$		In Tab. xix to alt. 50° and par. $59' 0''$ is	
.. Tab. A $59'$ parallax	38	.. Tab. C $59'$ parallax	19
.. Tab. B $6'$ altitude	4	Sought logarithm	1962
Sought correction	$22' 15''$		

EXAMPLE III.

Given the moon's apparent altitude $23^{\circ} 27'$, and horizontal parallax $54' 10''$. Required the correction and logarithm.

For the Correction.		For the Logarithm.	
In Tab. xix to alt. $23^{\circ} 20'$ and par. $54'$ is $13' 3''$		In Tab. xix to nearest alt. $23^{\circ} 30'$ and par. $54' 10''$ is	
.. Tab. A $54'$ parallax	43	.. Tab. C $54'$ parallax	19
.. Tab. B $7'$ altitude	5	Sought logarithm	2366
Sought correction	$13' 19''$		

TABLE XIX.

197

LOGARITHMS.

Apparent Altitude on δ - centre.TABLE C.
Cor for Seconds
of Parallax.
Add.

	25 0	25 20	25 40	26 0	26 20	26 40	27 0	27 20	27 40	28 0	28 20	28 40	29 0	29 20	29 40	S.	Cor.
2389	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	0	12
2375	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	1	11
2361	2359	2357	2355	2353	2351	2349	2347	2345	2343	2341	2339	2337	2335	2333	2331	2	9
2347	2345	2343	2341	2339	2337	2335	2333	2331	2329	2327	2325	2323	2321	2319	2317	3	8
2333	2332	2330	2327	2325	2323	2321	2318	2316	2313	2311	2309	2307	2305	2303	2301	4	6
2320	2318	2315	2313	2311	2309	2307	2304	2301	2299	2297	2295	2293	2291	2289	2287	5	5
2306	2304	2301	2299	2297	2295	2293	2291	2288	2286	2283	2281	2279	2277	2275	2273	6	4
2292	2290	2287	2285	2283	2281	2279	2277	2274	2272	2269	2267	2265	2263	2261	2259	7	2
2279	2277	2274	2272	2270	2268	2266	2264	2261	2258	2256	2253	2251	2249	2247	2245	8	1
2265	2263	2261	2259	2257	2255	2253	2250	2247	2245	2242	2240	2238	2236	2234	2232	9	0
2251	2249	2247	2245	2243	2241	2239	2236	2233	2231	2229	2227	2225	2223	2221	2219		
2238	2236	2234	2232	2230	2228	2226	2223	2220	2218	2216	2213	2211	2209	2207	2205	S.	Cor.
2224	2222	2220	2218	2216	2214	2212	2210	2207	2205	2203	2201	2199	2197	2195	2193	0	12
2211	2209	2207	2205	2203	2201	2199	2196	2193	2191	2189	2187	2185	2183	2181	2179	1	11
2198	2196	2192	2191	2189	2187	2185	2183	2180	2178	2175	2173	2171	2169	2167	2165	2	9
2184	2182	2180	2178	2176	2174	2172	2170	2167	2165	2162	2160	2158	2156	2154	2152	3	8
2171	2169	2167	2165	2163	2161	2159	2156	2153	2151	2148	2146	2144	2142	2140	2138	4	7
2158	2156	2153	2151	2149	2147	2145	2143	2140	2138	2135	2133	2131	2129	2127	2125	5	5
2144	2142	2140	2138	2136	2134	2132	2130	2127	2125	2122	2120	2118	2116	2114	2112	6	4
2131	2129	2127	2125	2123	2121	2119	2117	2114	2112	2109	2107	2105	2103	2101	2099	7	3
2118	2116	2114	2112	2110	2108	2106	2104	2101	2099	2096	2094	2092	2090	2088	2086	8	1
2105	2103	2101	2099	2097	2095	2093	2091	2088	2086	2083	2081	2079	2077	2075	2073	9	0
2092	2090	2088	2086	2084	2082	2080	2078	2075	2073	2070	2068	2066	2064	2062	2060		
2079	2077	2075	2073	2071	2069	2067	2065	2062	2060	2057	2055	2053	2051	2049	2047	S.	Cor.
2066	2064	2062	2060	2058	2056	2054	2052	2049	2047	2044	2042	2040	2038	2036	2034	0	12
2053	2051	2049	2047	2045	2043	2041	2039	2036	2034	2031	2029	2027	2025	2023	2021	1	11
2040	2038	2036	2034	2032	2030	2028	2026	2023	2021	2018	2016	2014	2012	2010	2008	2	9
2027	2025	2023	2021	2019	2017	2015	2013	2010	2008	2005	2003	2001	1999	1997	1995	3	8
2014	2012	2010	2008	2006	2004	2002	2000	1997	1995	1992	1990	1988	1986	1984	1982	4	7
2001	1999	1997	1995	1993	1991	1989	1987	1984	1982	1979	1977	1975	1973	1971	1969	5	6
1989	1987	1985	1983	1981	1979	1977	1975	1972	1970	1967	1965	1963	1961	1959	1957	6	4
1976	1974	1972	1970	1968	1966	1964	1962	1959	1957	1954	1952	1950	1948	1946	1944	7	3
1963	1961	1959	1957	1955	1953	1951	1949	1946	1944	1941	1939	1937	1935	1933	1931	8	2
1951	1949	1947	1945	1943	1941	1939	1937	1934	1932	1929	1927	1925	1923	1921	1919	9	0
1938	1936	1934	1932	1930	1928	1926	1924	1921	1919	1916	1914	1912	1910	1908	1906		
1925	1923	1921	1919	1917	1915	1913	1911	1908	1906	1903	1901	1899	1897	1895	1893	S.	Cor.
1913	1911	1909	1907	1905	1903	1901	1899	1896	1894	1891	1889	1887	1885	1883	1881	0	12
1900	1898	1896	1894	1892	1890	1888	1886	1883	1881	1878	1876	1874	1872	1870	1868	1	11
1888	1886	1884	1882	1880	1878	1876	1874	1871	1869	1866	1864	1862	1860	1858	1856	2	10
1875	1873	1871	1869	1867	1865	1863	1861	1858	1856	1853	1851	1849	1847	1845	1843	3	8
1863	1861	1859	1857	1855	1853	1851	1849	1846	1844	1841	1839	1837	1835	1833	1831	4	7
1851	1849	1847	1845	1843	1841	1839	1837	1834	1832	1829	1827	1825	1823	1821	1819	5	6
1838	1836	1834	1832	1830	1828	1826	1824	1821	1819	1816	1814	1812	1810	1808	1806	6	5
1826	1824	1822	1820	1818	1816	1814	1812	1809	1807	1804	1802	1800	1798	1796	1794	7	3
1814	1812	1810	1808	1806	1805	1803	1801	1797	1795	1793	1791	1789	1787	1785	1783	8	2
1801	1799	1798	1796	1794	1792	1790	1788	1785	1783	1781	1779	1777	1775	1773	1771	9	1

TABLE XIX.

CORRECTION.

Ap. alt. D. M.	) s. cen.	) s. Horizontal Parallax								TABLE A. Proportional part for Seconds of Parallax. Add										Tab. B. For M. of alt. Add.	
		54'	55'	56'	57'	58'	59'	60'	61'	8	9	10	11	12	13	14	15	16	17	M	S
		54'	55'	56'	57'	58'	59'	60'	61'	8	9	10	11	12	13	14	15	16	17		
30	0	12 43	12 51	11 59	11 7	10 15	9 23	8 31	7 39	0 51	50	49	48	47	46	45	44	43	42	0	51
	10	13 47	12 55	12 3	11 11	10 19	9 27	8 35	7 44	10 42	42	41	40	39	38	37	36	35	34	0	42
	20	13 51	12 59	12 7	11 16	10 24	9 32	8 40	7 48	20 34	33	32	31	30	29	28	27	26	25	0	34
	30	13 55	13 3	12 13	11 20	10 29	9 37	8 45	7 53	30 25	24	23	22	21	20	19	18	17	16	0	25
	40	13 59	13 8	12 16	11 24	10 33	9 41	8 49	7 58	40 17	16	15	14	13	12	11	10	9	8	0	17
	50	14 3	13 12	12 20	11 29	10 37	9 46	8 54	8 3	50 8	7	6	5	4	3	2	1	0	0	0	8
31	0	14 9	13 17	12 26	11 34	10 43	9 51	9 0	8 9	0 50	49	48	47	46	45	44	43	42	41	0	50
	10	14 13	13 22	12 30	11 39	10 47	9 56	9 5	8 13	10 41	41	40	39	38	37	36	35	34	33	0	41
	20	14 17	13 26	12 35	11 43	10 52	10 1	9 10	8 18	20 33	32	31	30	29	28	27	26	25	24	0	32
	30	14 21	13 30	12 39	11 48	10 57	10 6	9 14	8 23	30 24	24	23	22	21	20	19	18	17	16	0	24
	40	14 26	13 35	12 44	11 53	11 2	10 10	9 19	8 28	40 16	15	14	13	12	11	10	9	8	7	0	16
	50	14 30	13 39	12 48	11 57	11 6	10 15	9 24	8 33	50 7	6	5	4	3	2	1	0	0	0	0	7
32	0	14 35	13 44	12 53	12 2	11 11	10 20	9 29	8 38	0 50	49	48	47	46	45	44	43	42	41	0	50
	10	14 39	13 48	12 57	12 7	11 16	10 25	9 34	8 43	10 42	41	40	39	38	37	36	35	34	33	0	41
	20	14 43	13 53	13 2	12 11	11 21	10 30	9 39	8 48	20 33	32	31	30	29	28	27	26	25	24	0	32
	30	14 48	13 57	13 7	12 16	11 26	10 35	9 44	8 54	30 25	24	23	22	21	20	19	18	17	16	0	25
	40	14 52	14 2	13 11	12 21	11 30	10 40	9 49	8 59	40 16	15	14	13	12	11	10	9	8	7	0	16
	50	14 57	14 7	13 16	12 26	11 35	10 45	9 54	9 4	50 8	7	6	5	4	3	2	1	0	0	0	8
33	0	15 2	14 12	13 22	12 31	11 41	10 51	10 1	9 10	0 49	48	47	46	45	44	43	42	41	40	0	49
	10	15 7	14 17	13 27	12 36	11 46	10 56	10 6	9 15	10 41	40	39	38	37	36	35	34	33	32	0	40
	20	15 12	14 22	13 31	12 41	11 51	11 1	10 11	9 21	20 32	31	30	29	28	27	26	25	24	23	0	31
	30	15 16	14 26	13 36	12 46	11 56	11 6	10 16	9 26	30 24	23	22	21	20	19	18	17	16	15	0	24
	40	15 21	14 31	13 41	12 51	12 1	11 11	10 21	9 31	40 16	15	14	13	12	11	10	9	8	7	0	16
	50	15 26	14 36	13 46	12 56	12 6	11 17	10 27	9 37	50 7	6	5	4	3	2	1	0	0	0	0	7
34	0	15 31	14 41	13 51	13 1	12 11	11 22	10 32	9 42	0 49	48	47	46	45	44	43	42	41	40	0	49
	10	15 35	14 46	13 56	13 6	12 17	11 27	10 37	9 48	10 41	40	39	38	37	36	35	34	33	32	0	40
	20	15 40	14 50	14 1	13 11	12 22	11 32	10 43	9 53	20 32	32	31	30	29	28	27	26	25	24	0	32
	30	15 45	14 55	14 6	13 16	12 27	11 38	10 48	9 59	30 24	23	22	21	20	19	18	17	16	15	0	24
	40	15 50	15 0	14 11	13 22	12 32	11 43	10 54	10 4	40 16	15	14	13	12	11	10	9	8	7	0	16
	50	15 55	15 5	14 16	13 27	12 38	11 48	10 59	10 10	50 8	7	6	5	4	3	2	1	0	0	0	8
35	0	16 0	15 11	14 22	13 33	12 44	11 55	11 5	10 16	0 48	47	46	45	44	43	42	41	40	39	0	48
	10	16 5	15 16	14 27	13 38	12 49	12 0	11 11	10 22	10 40	39	38	37	36	35	34	33	32	31	0	39
	20	16 10	15 21	14 32	13 43	12 54	12 6	11 17	10 28	20 32	31	30	29	28	27	26	25	24	23	0	31
	30	16 15	15 26	14 38	13 49	13 0	12 11	11 22	10 33	30 24	23	22	21	20	19	18	17	16	15	0	24
	40	16 20	15 32	14 43	13 54	13 5	12 17	11 28	10 39	40 15	15	14	13	12	11	10	9	8	7	0	16
	50	16 25	15 37	14 48	13 59	13 11	12 22	11 33	10 45	50 7	6	5	4	3	2	1	0	0	0	0	8

EXAMPLE IV.

Given the moon's apparent altitude $76^{\circ} 36'$ and her horizontal parallax $56' 18''$. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. $76^{\circ} 30'$ and par. $56'$ is $46' 37''$
 .. Tab. A. $18''$ parallax 10
 .. Tab. B. $6'$ altitude 6
 Sought correction $46' 53''$

For the Logarithm.

In Tab. xix. to nearest alt. 77° and par. $56' 10''$ is 2112
 .. Tab. C. $8''$ parallax 9
 Sought logarithm 2119

EXAMPLE V.

Given the moon's apparent altitude $16^{\circ} 25'$ and her horizontal parallax $58' 45''$. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. $16^{\circ} 20'$ and par. $58'$ is $6' 17''$
 .. Tab. A. $45''$ parallax 14
 .. Tab. B. $5'$ altitude 0
 Sought correction $6' 31''$

For the Logarithm.

In Tab. xix. to nearest alt. $16^{\circ} 20'$ and par. $58' 40''$ is 2099
 .. Tab. C. $5''$ parallax 6
 Sought logarithm 2105

TABLE XIX.

109

LOGARITHMS.

Apparent Altitude of β 's centre.												TABLE C. Cor. for Seconds of Parallax. Add.	
	30'	31'	32'	33'	34'	35'	36'	37'	38'	39'	40'	S.	Cor.
360	2351	2356	2354	2352	2349	2347	2345	2344	2342	2340	2338	0	12
146	2344	2342	2340	2339	2336	2334	2332	2330	2328	2326	2324	1	11
133	2330	2328	2326	2324	2322	2320	2318	2316	2314	2313	2311	2	9
119	2316	2314	2312	2310	2308	2306	2304	2302	2300	2299	2297	3	8
105	2302	2300	2298	2296	2294	2292	2290	2289	2287	2285	2283	4	7
191	2289	2287	2285	2283	2281	2279	2277	2275	2274	2272	2270	5	5
178	2275	2273	2271	2269	2267	2265	2263	2262	2260	2258	2256	6	4
164	2262	2260	2258	2256	2254	2252	2250	2248	2246	2245	2243	7	2
151	2248	2246	2244	2242	2240	2238	2236	2234	2232	2231	2229	8	1
137	2235	2233	2231	2229	2227	2225	2223	2221	2219	2218	2216	9	0
124	2221	2219	2217	2215	2213	2211	2209	2208	2206	2204	2202		
111	2208	2206	2204	2202	2200	2198	2196	2194	2192	2191	2189	S.	Cor.
97	2194	2192	2190	2188	2186	2184	2182	2181	2179	2177	2175	0	12
83	2181	2179	2177	2175	2173	2171	2169	2168	2166	2164	2162	1	11
70	2168	2166	2164	2162	2160	2158	2156	2154	2152	2151	2149	2	9
57	2155	2153	2150	2148	2146	2145	2143	2141	2139	2138	2136	3	8
44	2141	2139	2137	2135	2133	2131	2129	2128	2126	2124	2122	4	7
30	2128	2126	2124	2122	2120	2118	2116	2115	2113	2111	2109	5	5
17	2115	2113	2111	2109	2107	2105	2103	2102	2100	2098	2096	6	4
04	2102	2100	2098	2096	2094	2092	2090	2089	2087	2085	2083	7	3
91	2089	2087	2085	2083	2081	2079	2077	2076	2074	2072	2070	8	1
78	2076	2074	2072	2070	2068	2066	2064	2063	2061	2059	2057	9	0
65	2063	2061	2059	2057	2055	2053	2051	2050	2048	2046	2044		
52	2050	2048	2046	2044	2042	2040	2038	2037	2035	2033	2031	S.	Cor.
39	2037	2035	2033	2031	2029	2027	2025	2024	2022	2020	2018	0	12
26	2024	2022	2020	2018	2016	2014	2013	2011	2009	2008	2006	1	11
13	2011	2009	2007	2005	2003	2002	2000	1998	1996	1995	1993	2	9
01	1998	1996	1994	1993	1991	1989	1987	1985	1983	1982	1980	3	8
38	1986	1984	1982	1980	1978	1976	1974	1973	1971	1969	1967	4	7
25	1973	1971	1969	1967	1965	1963	1961	1960	1958	1957	1955	5	5
12	1960	1958	1956	1954	1952	1951	1949	1947	1945	1944	1942	6	4
00	1948	1946	1944	1942	1940	1938	1936	1935	1933	1931	1930	7	3
37	1935	1933	1931	1929	1927	1925	1923	1922	1920	1919	1917	8	2
25	1923	1921	1919	1917	1915	1913	1911	1910	1908	1906	1904	9	1
12	1910	1908	1906	1904	1902	1900	1898	1897	1895	1894	1892		
00	1898	1896	1894	1892	1890	1888	1886	1885	1883	1881	1880	S.	Cor.
37	1885	1883	1881	1879	1877	1875	1873	1872	1870	1869	1867	0	12
25	1873	1871	1869	1867	1865	1863	1861	1860	1858	1857	1855	1	11
12	1860	1858	1856	1854	1852	1851	1849	1847	1845	1844	1842	2	10
00	1848	1846	1844	1842	1840	1838	1836	1835	1833	1832	1830	3	8
37	1835	1833	1831	1830	1828	1826	1824	1823	1821	1820	1818	4	7
25	1823	1821	1819	1817	1815	1814	1812	1811	1809	1807	1806	5	6
12	1811	1809	1807	1805	1803	1802	1800	1798	1796	1795	1793	6	5
00	1799	1797	1795	1793	1791	1789	1787	1786	1784	1783	1781	7	3
37	1787	1785	1783	1781	1779	1777	1775	1774	1772	1771	1769	8	2
25	1774	1772	1770	1769	1767	1765	1763	1762	1760	1759	1757	9	1

TABLE XIX.

CORRECTION.

App. alt. in cen		Moon's Horizontal Parallax									TABLE A Prop. part for Seconds of Paral. Add										Tab. B Part of alt. Add.							
D	M	54'	55	56'	57'	58'	59'	60'	61'	5	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	10	11	12	13	14	15		
36	0	16	31	15	43	14	54	14	6	13	17	12	29	11	40	10	51	0	47	46	45	45	44	43	42	41	41	40
	10	16	36	15	48	15	0	14	11	13	23	12	34	11	46	10	57	10	39	38	37	37	36	35	34	33	33	32
	20	16	42	15	53	15	5	14	17	13	28	12	40	11	51	11	3	20	31	30	29	28	28	27	26	25	24	24
	30	16	47	15	58	15	10	14	22	13	34	12	45	11	57	11	9	30	23	22	21	20	20	19	18	17	16	16
	40	16	52	16	4	15	16	14	27	13	39	12	51	12	3	11	15	40	15	14	13	12	12	11	10	9	8	8
	50	16	57	16	9	15	21	14	33	13	45	12	57	12	9	11	21	50	7	6	5	4	4	3	2	1	0	0
37	0	17	2	16	14	15	26	14	38	13	50	13	3	12	15	11	27	0	47	46	45	45	44	43	42	41	41	40
	10	17	7	16	20	15	32	14	44	13	56	13	8	12	20	11	33	10	39	38	37	37	36	35	34	34	33	32
	20	17	13	16	25	15	37	14	50	14	2	13	14	12	26	11	39	20	31	30	30	29	28	27	26	26	25	24
	30	17	18	16	30	15	43	14	55	14	8	13	20	12	32	11	45	30	23	22	22	21	20	19	18	18	17	16
	40	17	23	16	36	15	48	15	1	14	13	26	12	38	11	51	40	16	14	14	13	12	11	10	10	9	8	8
	50	17	29	16	41	15	54	15	6	14	19	13	32	12	44	11	57	50	7	7	6	5	4	3	3	2	1	0
38	0	17	35	16	48	16	0	15	13	14	26	13	38	12	51	12	4	0	46	45	44	44	43	42	41	41	40	39
	10	17	40	16	53	16	5	15	19	14	32	13	44	12	57	12	10	10	38	37	37	36	35	34	33	33	32	31
	20	17	46	16	59	16	12	15	25	14	37	13	50	13	3	12	16	20	30	30	29	28	27	26	26	25	24	23
	30	17	51	17	4	16	17	15	30	14	43	13	56	13	9	12	22	30	22	22	21	20	19	19	18	17	16	15
	40	17	57	17	10	16	23	15	36	14	49	14	2	13	16	12	29	40	16	14	13	12	12	11	10	9	8	8
	50	18	2	17	15	16	29	15	42	14	55	14	8	13	22	12	35	50	7	6	5	4	4	3	2	1	1	0
39	0	18	8	17	21	16	34	15	48	15	1	14	11	13	20	12	41	0	46	45	44	44	43	42	41	41	40	39
	10	18	13	17	27	16	40	15	54	15	7	14	20	13	34	12	47	10	38	37	37	36	35	34	34	33	32	31
	20	18	19	17	32	16	46	15	59	15	13	14	27	13	40	12	54	20	31	30	29	28	27	27	26	25	24	24
	30	18	24	17	38	16	52	16	5	15	19	14	33	13	46	13	0	30	23	22	21	20	20	19	18	17	17	16
	40	18	30	17	44	16	57	16	11	15	25	14	39	13	53	13	6	40	15	14	14	13	12	11	10	10	9	8
	50	18	36	17	49	17	3	16	17	15	31	14	45	13	59	13	13	50	7	7	6	5	4	3	3	2	1	0
40	0	18	42	17	56	17	10	16	21	15	38	14	52	14	6	13	20	0	45	44	43	43	42	41	40	40	39	38
	10	18	47	18	2	17	16	16	30	15	44	14	59	14	13	13	27	10	37	37	36	35	34	34	33	33	32	31
	20	18	53	18	8	17	22	16	36	15	51	15	5	14	19	13	33	20	30	29	28	27	27	26	25	24	24	23
	30	18	59	18	14	17	28	16	42	15	57	15	11	14	25	13	40	30	22	21	21	20	19	18	18	17	16	15
	40	19	5	18	19	17	34	16	48	16	3	15	17	14	32	13	46	40	15	14	13	12	11	11	10	9	8	8
	50	19	11	18	25	17	40	16	53	16	9	15	24	14	38	13	53	50	7	6	5	5	4	3	2	2	1	0
41	0	19	18	18	32	17	47	17	2	16	16	15	31	14	46	14	0	0	41	43	42	42	41	40	39	39	38	37
	10	19	23	18	38	17	53	17	8	16	23	15	37	14	52	14	7	10	36	36	35	34	33	33	32	31	30	30
	20	19	29	18	44	17	59	17	14	16	29	15	44	14	59	14	14	20	29	28	27	27	26	25	24	24	23	22
	30	19	34	18	50	18	5	17	20	16	35	15	50	15	5	14	20	30	21	21	20	19	18	18	17	16	15	15
	40	19	41	18	56	18	11	17	26	16	42	15	57	15	12	14	27	40	14	13	12	12	11	10	9	9	8	7
	50	19	47	19	2	18	17	17	32	16	48	16	3	15	19	14	34	50	6	6	5	4	3	3	2	1	0	0

EXAMPLE VI.

Given the moon's apparent altitude $11^{\circ} 20'$ and horizontal parallax $60' 43''$. Required the correction and logarithm.

To find the Correction.		To find the Logarithm.	
In Tab. xix. to alt. $11^{\circ} 20'$ and par. is $60' 4' 30''$		Tab. xix. to nearest alt. $11^{\circ} 20'$ and par. $60' 43''$	
.. Tab. A. 43" parallax	16	Tab. C. 3" parallax	
.. Tab. B. 0' altitude	2	Sought logarithm	561
Sought correction	$4' 48''$		

EXAMPLE VII.

Given the moon's apparent altitude $3^{\circ} 40'$ and horizontal parallax $56' 20''$. Required the correction and logarithm.

To find the Correction.		To find the Logarithm.	
In Tab. xix. to alt. $3^{\circ} 40'$ and par. is $56' 18''$		Tab. xix. to nearest alt. $3^{\circ} 39'$ and par. $56' 20''$	
.. Tab. A. 20" parallax	38	Tab. C. 0 parallax	
.. Tab. B. 0' altitude	5	Sought logarithm	221
Sought correction	$10' 1''$		

TABLE XIX.

111

LOGARITHMS.

Apparent Altitude of \odot 's centre.											TABLE C. Cor for Seconds of Parallax. Add	
	36 $\frac{1}{2}$ °	37°	37 $\frac{1}{2}$ °	38°	38 $\frac{1}{2}$ °	39°	39 $\frac{1}{2}$ °	40°	40 $\frac{1}{2}$ °	41°	S.	Cor.
17	2335	2334	2332	2331	2329	2328	2327	2326	2324	2323	0	12
25	2321	2320	2318	2317	2315	2314	2313	2312	2310	2309	1	11
19	2307	2306	2304	2303	2302	2301	2300	2298	2297	2296	2	9
16	2294	2293	2291	2290	2288	2287	2286	2285	2283	2282	3	8
12	2280	2279	2277	2276	2274	2273	2272	2271	2270	2268	4	7
18	2266	2265	2264	2263	2261	2260	2258	2257	2256	2255	5	5
15	2253	2252	2250	2249	2247	2246	2245	2244	2242	2241	6	4
11	2239	2238	2236	2235	2234	2233	2232	2230	2229	2228	7	2
8	2226	2225	2223	2222	2220	2219	2216	2217	2215	2214	8	1
4	2212	2211	2210	2209	2207	2206	2204	2203	2202	2201	9	0
1	2199	2198	2196	2195	2193	2192	2191	2190	2189	2188	Cor.	
13	2186	2185	2183	2182	2180	2179	2178	2177	2175	2174	0	12
4	2173	2171	2169	2168	2167	2166	2164	2163	2162	2161	1	11
1	2159	2158	2156	2155	2153	2152	2151	2150	2149	2148	2	9
8	2146	2145	2143	2142	2140	2139	2138	2137	2135	2134	3	8
5	2133	2132	2130	2129	2127	2126	2125	2124	2122	2121	4	7
1	2119	2118	2117	2116	2114	2113	2112	2111	2109	2108	5	5
15	2106	2105	2104	2103	2101	2100	2099	2097	2096	2095	6	4
5	2093	2092	2090	2089	2088	2087	2086	2084	2083	2082	7	3
2	2080	2079	2077	2076	2075	2074	2073	2071	2070	2069	8	2
9	2067	2066	2064	2063	2062	2061	2060	2058	2057	2056	9	0
6	2054	2053	2051	2050	2049	2048	2047	2046	2044	2043	Cor.	
3	2041	2040	2039	2038	2036	2035	2034	2033	2031	2030	0	12
0	2028	2027	2026	2025	2023	2022	2021	2020	2018	2017	1	11
7	2016	2015	2013	2012	2010	2009	2008	2007	2006	2005	2	9
4	2003	2002	2000	1999	1997	1996	1995	1994	1993	1992	3	8
2	1990	1989	1987	1986	1985	1984	1982	1981	1980	1979	4	7
9	1977	1976	1975	1974	1973	1971	1970	1969	1967	1966	5	6
6	1963	1964	1962	1961	1960	1958	1957	1956	1955	1954	6	4
4	1952	1951	1949	1948	1947	1946	1944	1943	1942	1941	7	3
1	1939	1938	1937	1936	1934	1933	1932	1931	1929	1928	8	2
9	1927	1926	1924	1923	1921	1920	1919	1918	1917	1916	9	1
6	1914	1913	1911	1910	1909	1908	1907	1906	1904	1903	Cor.	
3	1902	1901	1899	1898	1896	1895	1894	1893	1892	1891	0	12
1	1889	1888	1886	1885	1884	1883	1882	1881	1879	1878	1	11
9	1877	1876	1874	1873	1871	1870	1869	1868	1867	1866	2	9
5	1864	1863	1862	1861	1859	1858	1857	1856	1855	1854	3	8
1	1862	1851	1849	1848	1847	1846	1845	1844	1843	1841	4	7
1	1840	1839	1837	1836	1834	1833	1832	1831	1830	1829	5	6
3	1827	1826	1825	1824	1822	1821	1820	1819	1818	1817	6	5
7	1815	1814	1812	1811	1810	1809	1808	1807	1805	1804	7	3
5	1803	1802	1800	1799	1798	1797	1796	1795	1793	1792	8	2
2	1791	1790	1788	1787	1785	1784	1783	1782	1781	1780	9	1
0	1778	1777	1776	1775	1773	1772	1771	1770	1769	1768	Cor.	
8	1766	1765	1764	1763	1761	1760	1759	1758	1757	1756	0	12
5	1754	1753	1752	1751	1749	1748	1747	1746	1745	1744	1	11

TABLE XIX.

CORRECTION.

D	M	Horizontal Parallax								TABLE A Prop. part for Sec of Par Add								Tab. Folio Add
		54'	55'	56'	57'	58'	59'	60'	61'	50'	51'	52'	53'	54'	55'	56'	57'	
42	0	19	53	19	8	13	24	17	39	16	54	16	10	15	25	14	41	0
	10	19	54	19	14	18	30	17	45	17	1	16	16	15	32	14	47	10
	20	20	5	19	20	18	36	17	52	17	7	16	23	15	39	14	54	20
	30	20	11	19	26	18	42	17	58	17	14	16	29	15	45	15	1	30
	40	20	17	19	32	18	48	18	4	17	20	16	36	15	52	15	8	40
	50	20	23	19	39	18	55	18	11	17	27	16	43	15	59	15	15	50
43	0	20	30	19	46	19	2	18	18	17	34	16	50	16	6	15	23	0
	10	20	36	19	52	19	8	18	25	17	41	16	57	16	13	13	30	10
	20	20	42	19	58	19	15	18	31	17	47	17	4	16	20	13	37	20
	30	20	48	20	5	19	21	18	38	17	54	17	11	16	27	15	44	30
	40	20	54	20	11	19	28	18	44	18	1	17	17	16	34	15	51	40
	50	21	0	20	17	19	34	18	51	18	7	17	24	16	41	15	58	50
44	0	21	6	20	28	19	41	18	58	18	13	17	32	16	49	16	6	0
	10	21	14	20	31	19	48	19	5	18	22	17	39	16	56	16	13	10
	20	21	20	20	37	19	54	19	11	18	28	17	46	17	3	16	20	20
	30	21	26	20	44	20	1	19	18	18	35	17	53	17	10	16	27	30
	40	21	32	20	50	20	7	19	25	18	42	17	59	17	17	16	34	40
	50	21	39	20	56	20	14	19	31	18	49	18	6	17	24	16	41	50
45	0	21	46	21	4	20	21	19	39	18	57	18	14	17	32	16	49	0
	10	21	53	21	10	20	28	19	46	19	3	18	21	17	39	16	57	10
	20	21	59	21	17	20	35	19	52	19	10	18	28	17	46	17	4	20
	30	22	5	21	24	20	41	19	59	19	17	18	35	17	53	17	11	30
	40	22	12	21	30	20	48	20	6	19	24	18	42	17	0	17	18	40
	50	22	18	21	36	20	55	20	13	19	31	18	49	18	7	17	26	50
46	0	22	25	21	43	21	1	20	20	19	38	18	56	18	15	17	33	0
	10	22	31	21	50	21	8	20	27	19	45	19	3	18	22	17	40	10
	20	22	37	21	56	21	15	20	33	19	52	19	11	18	29	17	48	20
	30	22	44	22	3	21	22	20	40	19	59	19	18	18	36	17	55	30
	40	22	51	22	10	21	29	20	47	20	6	19	25	18	44	18	2	40
	50	22	57	22	16	21	35	20	54	20	13	19	32	18	51	18	10	50
47	0	23	5	22	24	21	43	21	2	20	21	19	40	18	59	18	18	0
	10	23	11	22	31	21	50	21	9	20	28	19	47	19	7	18	26	10
	20	23	18	22	37	21	57	21	16	20	35	19	55	19	14	18	33	20
	30	23	25	22	44	22	4	21	23	20	43	20	2	19	21	18	41	30
	40	23	31	22	51	22	11	21	30	20	50	20	9	19	29	18	48	40
	50	23	38	22	58	22	18	21	37	20	57	20	17	19	36	18	56	50
48	0	23	46	23	6	22	25	21	45	21	5	20	25	19	45	19	5	0
	10	23	52	23	12	22	32	21	52	21	12	20	32	19	52	19	12	10
	20	23	59	23	19	22	39	22	0	21	20	20	40	20	0	19	20	20
	30	24	6	23	26	22	46	22	7	21	27	20	47	20	7	19	28	30
	40	24	13	23	33	22	53	22	14	21	34	20	55	20	15	19	35	40
	50	24	20	23	40	23	1	22	21	21	42	21	2	20	23	19	43	50
49	0	24	27	23	46	23	9	22	29	21	50	21	10	20	31	19	52	0
	10	24	34	23	53	23	16	22	36	21	57	21	18	20	39	20	0	10
	20	24	41	24	2	24	23	44	22	5	21	26	20	46	20	7	20	20
	30	24	48	24	9	24	30	22	51	22	12	21	33	20	54	20	15	30
	40	24	55	24	16	23	37	22	58	22	19	21	41	21	2	20	23	40
	50	25	2	24	23	23	44	23	6	22	27	21	48	21	9	20	31	50

TABLE XIX.

113

LOGARITHMS.

M	S	Apparent Altitude of γ 's centre.												TABLE C. Cor for Seconds of Parallax. Add.	
		42°	42½	43°	43½	44°	44½	45°	45½	46°	47°	48°	49°	S.	Cor
54	0	2321	2320	2319	2318	2317	2316	2315	2314	2313	2311	2309	2308	0	12
	10	2307	2306	2305	2304	2303	2302	2301	2300	2299	2297	2296	2294	1	11
	20	2293	2292	2291	2290	2289	2288	2287	2286	2285	2284	2282	2280	2	9
	30	2280	2279	2278	2277	2276	2275	2274	2273	2272	2270	2268	2267	3	8
	40	2266	2265	2264	2263	2262	2261	2260	2259	2258	2256	2255	2253	4	7
	50	2253	2251	2250	2249	2248	2247	2246	2245	2243	2241	2240		5	5
55	0	2239	2238	2237	2236	2235	2234	2233	2232	2231	2229	2228	2226	6	4
	10	2226	2224	2223	2222	2221	2220	2219	2218	2216	2214	2213		7	3
	20	2212	2211	2210	2209	2208	2207	2206	2205	2204	2203	2201	2199	8	1
	30	2199	2198	2197	2196	2195	2194	2193	2192	2191	2189	2188	2186	9	0
	40	2185	2184	2183	2182	2181	2180	2179	2179	2178	2176	2174	2173		
	50	2172	2171	2170	2169	2168	2167	2166	2165	2164	2163	2161	2159	S.	Cor
56	0	2159	2158	2157	2156	2155	2154	2153	2152	2151	2149	2148	2146	0	12
	10	2146	2144	2143	2142	2141	2140	2139	2138	2136	2134	2133		1	11
	20	2132	2131	2130	2129	2128	2127	2126	2125	2123	2121	2120		2	9
	30	2119	2118	2117	2116	2115	2114	2113	2112	2111	2110	2108	2107	3	8
	40	2106	2105	2104	2103	2102	2101	2100	2099	2098	2097	2095	2093	4	7
	50	2093	2092	2091	2090	2089	2088	2087	2086	2085	2084	2082	2080	5	5
57	0	2080	2079	2078	2077	2076	2075	2074	2073	2072	2071	2069	2067	6	4
	10	2067	2066	2065	2064	2063	2062	2061	2060	2059	2058	2056	2054	7	3
	20	2054	2053	2052	2051	2050	2049	2048	2047	2046	2045	2043	2042	8	2
	30	2041	2040	2039	2038	2037	2036	2035	2034	2033	2032	2030	2029	9	0
	40	2028	2027	2026	2025	2024	2023	2022	2021	2021	2019	2017	2016		
	50	2015	2014	2013	2012	2011	2010	2009	2008	2008	2006	2005	2003	S.	Cor
58	0	2002	2001	2000	1999	1998	1998	1997	1996	1995	1993	1992	1990	0	12
	10	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1979	1977	1	11
	20	1977	1976	1975	1974	1973	1972	1971	1970	1970	1968	1966	1965	2	9
	30	1964	1963	1962	1961	1960	1959	1958	1957	1957	1955	1954	1952	3	8
	40	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1941	1939	4	7
	50	1939	1938	1937	1936	1935	1934	1933	1932	1932	1930	1928	1927	5	6
59	0	1926	1925	1924	1923	1922	1922	1921	1920	1919	1917	1916	1914	6	4
	10	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1903	1902	7	3
	20	1901	1900	1899	1898	1897	1897	1896	1895	1894	1892	1891	1889	8	2
	30	1889	1888	1887	1886	1885	1884	1883	1882	1882	1880	1878	1877	9	1
	40	1876	1875	1874	1873	1872	1872	1871	1870	1869	1867	1866	1864		
	50	1864	1863	1862	1861	1860	1859	1858	1857	1857	1855	1854	1852	S.	Cor.
60	0	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1841	1840	0	12
	10	1839	1838	1837	1836	1835	1835	1834	1833	1832	1830	1829	1827	1	11
	20	1827	1826	1825	1824	1823	1822	1821	1820	1820	1818	1817	1815	2	10
	30	1815	1814	1813	1812	1811	1810	1809	1808	1808	1806	1804	1803	3	9
	40	1802	1801	1800	1800	1799	1798	1797	1796	1795	1794	1792	1791	4	7
	50	1790	1789	1788	1787	1786	1786	1785	1784	1783	1782	1780	1779	5	6
61	0	1778	1777	1776	1775	1774	1774	1773	1772	1771	1769	1768	1766	6	5
	10	1766	1765	1764	1763	1762	1761	1760	1759	1759	1757	1756	1754	7	3
	20	1754	1753	1752	1751	1750	1749	1748	1747	1747	1745	1744	1742	8	2
	30	1742	1741	1740	1739	1738	1737	1736	1735	1735	1733	1732	1730	9	1

TABLE XIX.

115

LOGARITHMS.

N	S	Apparent Altitude of γ 's centre										TABLE C. Cor. for Seconds of Parallax. Add.	
		60°	51°	52°	53°	54°	55°	56°	57°	58°	59°	S.	Cor.
54	0	2306	2305	2303	2302	2301	2300	2298	2297	2296	2295	0	12
	10	2293	2291	2290	2288	2287	2286	2285	2284	2283	2282	1	11
	20	2279	2277	2276	2275	2274	2272	2271	2270	2269	2268	2	9
	30	2265	2264	2262	2261	2260	2259	2258	2257	2256	2254	3	8
	40	2252	2250	2249	2248	2246	2245	2244	2243	2242	2241	4	7
	50	2238	2237	2235	2234	2233	2232	2230	2230	2229	2227	5	5
55	0	2225	2223	2222	2221	2219	2218	2217	2216	2215	2214	6	4
	10	2211	2210	2208	2207	2206	2205	2204	2203	2202	2201	7	3
	20	2198	2196	2195	2194	2193	2191	2190	2189	2188	2187	8	1
	30	2184	2183	2182	2180	2179	2178	2177	2176	2175	2174	9	0
	40	2171	2170	2168	2167	2166	2165	2164	2163	2162	2161		
	50	2158	2156	2155	2154	2153	2152	2150	2149	2148	2147	S.	Cor.
56	0	2145	2143	2142	2141	2139	2138	2137	2136	2135	2134	0	12
	10	2131	2130	2129	2127	2126	2125	2124	2123	2122	2121	1	11
	20	2118	2117	2116	2114	2113	2112	2111	2110	2109	2108	2	9
	30	2105	2104	2102	2101	2100	2099	2098	2097	2096	2095	3	8
	40	2092	2091	2089	2088	2087	2086	2085	2084	2083	2082	4	7
	50	2079	2078	2076	2075	2074	2073	2072	2071	2070	2069	5	5
57	0	2066	2065	2063	2062	2061	2060	2059	2058	2057	2056	6	4
	10	2053	2052	2050	2049	2048	2047	2046	2045	2044	2043	7	3
	20	2040	2039	2037	2036	2035	2034	2033	2032	2031	2030	8	2
	30	2027	2026	2025	2023	2022	2021	2020	2019	2018	2017	9	0
	40	2014	2013	2012	2010	2009	2008	2007	2006	2005	2004		
	50	2002	2000	1999	1998	1997	1996	1994	1993	1992	1991	S.	Cor.
58	0	1989	1987	1986	1985	1984	1983	1982	1981	1980	1979	0	12
	10	1976	1975	1973	1972	1971	1970	1969	1968	1967	1966	1	11
	20	1963	1962	1961	1960	1958	1957	1956	1955	1954	1953	2	9
	30	1951	1949	1948	1947	1946	1945	1944	1943	1942	1941	3	8
	40	1938	1937	1936	1934	1933	1932	1931	1930	1929	1928	4	7
	50	1926	1924	1923	1922	1921	1920	1918	1917	1917	1916	5	6
59	0	1913	1912	1910	1909	1908	1907	1906	1905	1904	1903	6	4
	10	1901	1899	1898	1897	1896	1895	1893	1892	1892	1891	7	3
	20	1888	1887	1885	1884	1883	1882	1881	1880	1879	1878	8	2
	30	1876	1874	1873	1872	1871	1870	1869	1868	1867	1866	9	1
	40	1863	1862	1861	1859	1858	1857	1856	1855	1854	1853		
	50	1851	1849	1848	1847	1846	1845	1844	1843	1842	1841	S.	Cor.
60	0	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829	0	12
	10	1826	1825	1824	1822	1821	1820	1819	1818	1817	1816	1	11
	20	1814	1813	1811	1810	1809	1808	1807	1806	1805	1804	2	10
	30	1802	1800	1799	1798	1797	1796	1795	1794	1793	1792	3	8
	40	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780	4	7
	50	1777	1776	1775	1774	1773	1771	1770	1770	1769	1768	5	6
61	0	1765	1764	1763	1761	1760	1759	1758	1757	1757	1756	6	5
	10	1753	1752	1751	1749	1748	1747	1746	1745	1744	1743	7	3
	20	1741	1740	1739	1737	1736	1735	1734	1733	1732	1731	8	2
	30	1729	1728	1727	1725	1724	1723	1722	1721	1720	1719	9	1

TABLE XIX.

117

LOGARITHMS.

TABLE C.
Cor. for Seconds
of Parallax.
Add.

		Apparent Altitude of γ 's centre.											
		60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	S.	Cor.
54	0	2295	2294	2293	2292	2291	2291	2290	2289	2289	2288	0	12
	10	2281	2280	2279	2278	2278	2277	2276	2276	2275	2274	1	11
	20	2267	2266	2266	2265	2264	2263	2263	2262	2261	2261	2	9
	30	2254	2253	2252	2251	2250	2250	2249	2248	2248	2247	3	8
	40	2240	2239	2238	2238	2237	2236	2236	2235	2234	2234	4	7
	50	2227	2226	2225	2224	2223	2223	2222	2221	2221	2220	5	5
55	0	2213	2212	2212	2211	2210	2209	2209	2208	2207	2207	6	4
	10	2200	2199	2198	2197	2197	2196	2195	2195	2194	2194	7	3
	20	2186	2186	2185	2184	2183	2183	2182	2181	2181	2180	8	1
	30	2173	2172	2171	2171	2170	2169	2169	2168	2167	2167	9	0
	40	2160	2159	2158	2157	2157	2156	2155	2155	2154	2154		
	50	2147	2146	2145	2144	2143	2143	2142	2141	2141	2140	S.	Cor.
56	0	2133	2133	2132	2131	2130	2130	2129	2128	2128	2127	0	12
	10	2120	2119	2119	2118	2117	2116	2116	2115	2114	2114	1	11
	20	2107	2106	2105	2105	2104	2103	2103	2102	2101	2101	2	9
	30	2094	2093	2092	2092	2091	2090	2090	2089	2088	2088	3	8
	40	2081	2080	2079	2078	2078	2077	2077	2076	2075	2075	4	7
	50	2068	2067	2066	2065	2065	2064	2064	2063	2062	2062	5	5
57	0	2053	2054	2053	2053	2052	2051	2051	2050	2049	2049	6	4
	10	2042	2041	2040	2040	2039	2038	2038	2037	2036	2036	7	3
	20	2029	2028	2028	2027	2026	2025	2025	2024	2024	2023	8	2
	30	2016	2016	2015	2014	2013	2013	2012	2011	2011	2010	9	0
	40	2004	2003	2002	2001	2000	2000	1999	1999	1998	1998		
	50	1991	1990	1989	1988	1988	1987	1986	1986	1985	1985	S.	Cor.
58	0	1978	1977	1976	1976	1975	1974	1974	1973	1972	1972	0	12
	10	1965	1965	1964	1963	1962	1962	1961	1960	1960	1959	1	11
	20	1953	1952	1951	1950	1950	1949	1948	1948	1947	1947	2	9
	30	1940	1939	1938	1938	1937	1936	1936	1935	1934	1934	3	8
	40	1927	1927	1926	1925	1924	1924	1923	1923	1922	1921	4	7
	50	1915	1914	1913	1912	1912	1911	1911	1910	1909	1909	5	6
59	0	1902	1902	1901	1900	1899	1899	1898	1898	1897	1896	6	4
	10	1890	1889	1888	1887	1887	1886	1886	1885	1884	1884	7	3
	20	1877	1877	1876	1875	1874	1874	1873	1873	1872	1872	8	2
	30	1865	1864	1863	1863	1862	1861	1861	1860	1860	1859	9	1
	40	1853	1852	1851	1850	1850	1849	1848	1848	1847	1847		
	50	1840	1840	1839	1838	1837	1837	1836	1836	1835	1834	S.	Cor.
60	0	1828	1827	1826	1826	1825	1824	1824	1823	1823	1822	0	12
	10	1816	1815	1814	1813	1813	1812	1812	1811	1810	1810	1	11
	20	1803	1803	1802	1801	1801	1800	1799	1799	1798	1798	2	10
	30	1791	1791	1790	1789	1788	1788	1787	1787	1786	1786	3	8
	40	1779	1778	1778	1777	1776	1776	1775	1774	1774	1773	4	7
	50	1767	1766	1765	1765	1764	1763	1763	1762	1762	1761	5	6
61	0	1755	1754	1753	1753	1752	1751	1751	1750	1750	1749	6	5
	10	1743	1742	1741	1740	1740	1739	1739	1738	1737	1737	7	4
	20	1731	1730	1729	1728	1728	1727	1727	1726	1725	1725	8	2
	30	1719	1718	1717	1716	1716	1715	1715	1714	1713	1713	9	1

TABLE XIX.

CORRECTION.

App. alt. D's cent.		D's Horizontal Parallax								TABLE A. Correction for Sec. of Par. Add										Tab. Par. of alt. Add.					
		D	M	54'	55'	56'	57'	58'	59'	60'	61'	S	0'	1'	2'	3'	4'	5'	6'	7'	8'	9'	D	S	
70	0	41	11	40	54	40	33	40	13	39	52	39	32	39	11	38	51	0	20	19	19	18	18	17	17
	10	41	23	41	3	40	42	40	22	40	2	39	41	39	21	39	1	10	17	16	16	15	15	14	14
	20	41	32	41	12	40	51	40	31	40	11	39	51	39	31	39	10	20	13	13	13	12	12	11	11
	30	41	40	41	20	41	0	40	40	20	40	0	39	40	39	20	30	10	10	9	9	8	8	7	7
	40	41	45	41	29	41	9	40	50	40	30	40	10	39	50	39	30	40	7	6	6	5	5	4	4
71	0	41	55	41	38	41	18	40	59	40	39	40	19	40	0	39	40	50	3	3	3	2	2	1	1
	10	42	3	41	48	41	28	41	9	40	49	40	30	40	10	39	51	0	19	19	18	18	17	17	16
	20	42	16	41	57	41	38	41	18	40	59	40	39	40	20	40	1	10	16	15	15	15	14	14	13
	30	42	25	42	6	41	47	41	27	41	8	40	49	40	30	40	11	20	13	12	12	12	11	11	10
	40	42	34	42	15	41	56	41	37	41	18	40	59	40	39	40	20	30	9	9	9	8	8	7	7
72	0	42	43	42	24	42	5	41	46	41	27	41	8	40	49	40	30	40	6	6	6	5	5	4	4
	10	42	51	42	3	42	13	41	55	41	36	41	18	40	59	40	40	50	3	3	2	2	2	1	1
	20	43	1	42	12	42	24	42	5	41	47	41	28	41	10	40	51	0	18	18	17	17	16	16	15
	30	43	10	42	51	42	33	42	15	41	56	41	38	41	20	41	1	10	15	15	15	15	14	14	13
	40	43	19	43	0	42	42	42	24	42	6	41	48	41	29	41	11	20	13	12	12	12	11	11	10
73	0	43	27	43	9	42	51	42	33	42	15	41	57	41	39	41	21	30	9	9	8	8	7	7	6
	10	43	36	43	19	43	0	42	43	42	25	42	7	41	49	41	31	40	6	6	5	5	4	4	3
	20	43	45	43	27	43	10	42	52	42	34	42	17	41	59	41	41	50	3	3	2	2	2	1	1
	30	43	54	43	36	43	2	42	43	42	34	42	17	41	59	41	41	0	17	17	16	16	15	15	14
	40	43	63	43	45	43	11	42	54	42	37	42	19	42	2	10	14	10	14	14	13	13	12	12	12
74	0	43	72	43	55	43	38	43	21	43	4	42	47	42	29	42	12	20	11	11	10	10	9	9	9
	10	44	1	43	18	43	29	43	12	42	54	42	37	42	19	42	2	30	8	8	8	7	7	6	6
	20	44	10	43	35	43	38	43	21	43	4	42	47	42	29	42	12	40	6	5	5	4	4	4	3
	30	44	19	43	54	43	47	43	30	43	13	42	56	42	39	42	22	50	3	3	2	2	2	1	1
	40	44	28	43	1	43	57	43	40	43	23	43	6	42	49	42	32	0	16	16	15	15	14	14	14
75	0	44	37	43	10	43	6	43	49	42	32	43	16	42	59	42	42	10	15	15	15	15	14	14	14
	10	44	46	43	19	43	18	43	17	43	12	43	25	43	36	43	20	20	13	13	13	12	12	11	11
	20	44	55	43	28	43	27	43	26	43	21	43	34	43	45	43	29	30	11	10	10	10	9	9	8
	30	44	64	43	37	43	36	43	35	43	30	43	43	43	54	43	38	40	8	8	7	7	6	6	5
	40	44	73	43	46	43	45	43	44	43	39	43	52	43	63	43	47	50	6	5	5	4	4	3	3
76	0	44	82	43	56	43	54	43	53	43	48	43	61	43	72	43	56	40	5	5	4	4	4	3	3
	10	45	1	43	5	43	63	43	62	43	57	43	66	43	77	43	65	40	3	3	2	2	2	1	1
	20	45	10	43	14	43	72	43	71	43	66	43	75	43	86	43	74	50	2	2	2	1	1	1	0
	30	45	19	43	23	43	81	43	80	43	75	43	84	43	95	43	83	50	1	1	1	1	1	0	0
	40	45	28	43	32	43	90	43	89	43	84	43	93	43	104	43	92	50	0	0	0	0	0	0	0
77	0	45	37	43	41	43	99	43	98	43	93	43	102	43	113	43	101	0	15	15	14	14	13	13	12
	10	45	46	43	50	43	108	43	107	43	102	43	111	43	122	43	110	10	12	12	12	11	11	10	10
	20	45	55	43	59	43	117	43	116	43	111	43	120	43	131	43	119	20	10	10	9	9	8	8	7
	30	45	64	43	68	43	126	43	125	43	120	43	129	43	140	43	128	30	7	7	7	6	6	5	5
	40	45	73	43	77	43	135	43	134	43	129	43	138	43	149	43	137	40	5	4	4	3	3	3	2
78	0	45	82	43	86	43	144	43	143	43	138	43	147	43	158	43	146	50	2	2	2	1	1	1	0
	10	46	1	43	95	43	153	43	152	43	147	43	156	43	167	43	155	0	14	14	13	13	12	12	11
	20	46	10	43	104	43	162	43	161	43	156	43	165	43	176	43	164	10	12	11	11	10	10	9	8
	30	46	19	43	113	43	171	43	170	43	165	43	174	43	185	43	173	20	9	9	8	8	7	6	5
	40	46	28	43	122	43	180	43	179	43	174	43	183	43	194	43	182	30	7	7	6	6	5	4	3
79	0	46	37	43	131	43	189	43	188	43	183	43	192	43	203	43	191	40	5	4	4	3	3	2	2
	10	46	46	43	140	43	198	43	197	43	192	43	201	43	212	43	200	50	2	2	2	1	1	1	0
	20	46	55	43	149	43	207	43	206	43	201	43	210	43	221	43	209	0	13	13	12	12	11	11	10
	30	46	64	43	158	43	216	43	215	43	210	43	219	43	230	43	218	10	11	10	10	9	8	8	7
	40	46	73	43	167	43	225	43	224	43	219	43	228	43	239	43	227	20	9	8	8	7	6	5	4

TABLE XIX.

119

LOGARITHMS.

β's Hor. Parallax.		Apparent Altitude of β's centre.										TABLE C. Cor. for Seconds of Parallax. Add.	
	S	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	S.	Cor.
54	0	2287	2287	2286	2286	2285	2285	2285	2284	2284	2284	0	12
	10	2274	2273	2273	2272	2272	2272	2271	2271	2271	2271	1	11
	20	2260	2260	2259	2259	2258	2258	2258	2257	2257	2257	2	10
	30	2247	2246	2246	2245	2245	2245	2244	2243	2243	2243	3	9
	40	2233	2233	2232	2232	2231	2231	2231	2230	2230	2230	4	8
	50	2220	2219	2219	2218	2218	2218	2217	2217	2216	2216	5	7
55	0	2206	2206	2205	2205	2204	2204	2204	2203	2203	2203	6	6
	10	2193	2192	2192	2191	2191	2191	2190	2190	2190	2190	7	5
	20	2179	2179	2179	2178	2178	2178	2177	2176	2176	2176	8	4
	30	2166	2166	2165	2165	2164	2164	2164	2163	2163	2163	9	3
	40	2153	2152	2152	2152	2151	2151	2150	2150	2150	2150		2
	50	2140	2139	2139	2138	2138	2138	2137	2137	2137	2137	S	Cor.
56	0	2126	2126	2126	2125	2125	2125	2124	2123	2123	2123	0	12
	10	2113	2113	2112	2112	2112	2111	2111	2110	2110	2110	1	11
	20	2100	2100	2099	2099	2098	2098	2098	2097	2097	2097	2	10
	30	2087	2087	2086	2086	2085	2085	2085	2084	2084	2084	3	9
	40	2074	2074	2073	2073	2072	2072	2072	2071	2071	2071	4	8
	50	2061	2061	2060	2060	2059	2059	2059	2058	2058	2058	5	7
57	0	2048	2048	2047	2047	2046	2046	2046	2045	2045	2045	6	6
	10	2035	2035	2034	2034	2034	2033	2033	2032	2032	2032	7	5
	20	2022	2022	2021	2021	2021	2020	2020	2019	2019	2019	8	4
	30	2010	2009	2009	2008	2008	2007	2007	2007	2007	2007	9	3
	40	1997	1996	1996	1995	1995	1994	1994	1994	1994	1994		2
	50	1984	1984	1983	1983	1982	1982	1982	1981	1981	1981	S	Cor.
58	0	1971	1971	1970	1970	1970	1969	1969	1968	1968	1968	0	12
	10	1959	1958	1958	1957	1957	1956	1956	1956	1956	1956	1	11
	20	1946	1946	1945	1945	1944	1944	1944	1943	1943	1943	2	10
	30	1933	1933	1933	1932	1932	1931	1931	1931	1930	1930	3	9
	40	1921	1920	1920	1920	1919	1919	1919	1917	1917	1917	4	8
	50	1908	1908	1907	1907	1907	1906	1906	1905	1905	1905	5	7
59	0	1896	1895	1895	1895	1894	1894	1893	1893	1893	1893	6	6
	10	1883	1883	1882	1882	1882	1881	1881	1880	1880	1880	7	5
	20	1871	1870	1870	1870	1869	1869	1869	1868	1868	1868	8	4
	30	1858	1858	1858	1857	1857	1856	1856	1856	1856	1856	9	3
	40	1846	1846	1845	1845	1844	1844	1844	1843	1843	1843		2
	50	1834	1833	1833	1833	1832	1832	1832	1831	1831	1831	S	Cor.
60	0	1822	1821	1821	1820	1820	1819	1819	1819	1819	1819	0	12
	10	1809	1809	1808	1808	1808	1808	1807	1806	1806	1806	1	11
	20	1797	1797	1796	1796	1795	1795	1795	1794	1794	1794	2	10
	30	1785	1784	1784	1784	1783	1783	1783	1782	1782	1782	3	9
	40	1773	1772	1772	1771	1771	1771	1770	1770	1770	1770	4	8
	50	1761	1760	1760	1759	1759	1759	1758	1758	1758	1758	5	7
61	0	1749	1748	1748	1747	1747	1747	1746	1746	1746	1746	6	6
	10	1736	1736	1736	1735	1735	1735	1734	1734	1734	1734	7	5
	20	1724	1724	1724	1723	1723	1723	1722	1722	1722	1722	8	4
	30	1712	1712	1712	1711	1711	1711	1710	1710	1710	1710	9	3

App. alt. in cent.		Sun's Horizontal Parallax.										TABLE A. Proport. part for Sec. of Par Add.										Tab. Form of alt. Add.	
D	M	54'	55'	56'	57'	58'	59'	60'	61'	S	0'	1	2	3	4	5	6	7	8	9	M	S	
80	0	50	19	30	9	49	58	49	48	49	38	49	27	19	17	49	6	0	10	10	10	10	9
	10	50	28	50	18	50	8	49	58	49	47	49	37	19	27	49	17	10	8	8	8	8	7
	20	50	37	50	27	50	17	50	7	49	57	49	47	49	37	49	27	20	7	7	6	6	6
	30	50	47	50	37	50	27	50	17	50	7	49	57	49	47	49	37	30	5	5	5	5	4
	40	50	56	50	46	50	36	50	27	50	17	50	7	49	57	49	48	40	3	3	3	3	3
	50	51	5	50	55	50	46	50	36	50	27	50	17	50	8	49	58	50	2	2	1	1	1
81	0	51	15	51	6	50	56	50	47	50	37	50	28	50	19	50	9	0	9	9	9	9	8
	10	51	24	51	15	51	6	50	57	50	47	50	38	50	29	50	20	10	8	7	7	7	7
	20	51	33	51	24	51	15	51	6	50	57	50	48	50	39	50	30	20	6	6	6	6	5
	30	51	42	51	34	51	25	51	16	51	7	50	58	50	40	50	40	30	5	4	4	4	4
	40	51	52	51	43	51	35	51	26	51	17	51	8	50	50	51	51	40	3	3	3	3	2
	50	52	1	51	52	51	44	51	35	51	27	51	18	51	10	51	1	50	2	1	1	1	1
82	0	52	11	52	3	51	54	51	46	51	36	51	29	51	21	51	13	0	8	8	8	8	7
	10	52	20	52	12	52	4	51	56	51	47	51	39	51	31	51	24	10	7	7	6	6	6
	20	52	29	52	21	52	13	52	5	51	57	51	49	51	41	51	35	20	5	5	5	5	5
	30	52	39	52	31	52	23	52	15	52	7	51	59	51	52	51	44	30	4	4	4	4	4
	40	52	48	52	40	52	32	52	25	52	17	52	9	52	53	51	54	40	3	3	2	2	2
	50	52	57	52	49	52	42	52	34	52	27	52	19	52	12	52	4	50	1	1	1	1	1
83	0	53	7	53	0	52	52	52	45	52	38	52	30	52	23	52	16	0	7	7	7	7	6
	10	53	16	53	9	53	2	52	55	52	48	52	41	52	33	52	26	10	6	6	6	6	5
	20	53	25	53	18	53	11	53	6	52	58	52	51	52	44	52	37	20	5	5	4	4	4
	30	53	33	53	28	53	21	53	14	53	7	53	1	52	54	52	47	30	4	3	3	3	3
	40	53	44	53	37	53	31	53	24	53	17	53	11	53	4	52	57	40	2	2	2	2	2
	50	53	53	53	47	53	40	53	34	53	27	53	21	53	14	53	8	50	1	1	1	1	1
84	0	54	3	54	57	54	51	54	44	54	3	53	32	54	25	54	19	0	6	6	6	6	5
	10	54	12	54	6	54	0	53	54	53	48	54	42	54	36	54	30	10	5	5	5	5	4
	20	54	22	54	16	54	10	54	4	53	58	54	52	54	46	54	40	20	4	4	4	4	4
	30	54	31	54	25	54	19	54	14	54	8	54	2	53	56	54	51	30	3	3	3	3	3
	40	54	40	54	35	54	29	54	23	54	18	54	12	54	7	54	1	40	2	2	2	2	2
	50	54	49	54	44	54	39	54	33	54	27	54	22	54	17	54	11	50	1	1	1	1	1
85	0	55	0	54	54	54	49	54	41	54	3	54	33	54	28	54	23	0	5	5	5	5	5
	10	55	9	55	4	54	59	54	51	54	4	54	43	54	39	54	33	10	4	4	4	4	4
	20	55	18	55	13	55	8	55	3	54	57	54	51	54	49	54	41	20	3	3	3	3	3
	30	55	27	55	23	55	18	55	13	55	8	55	4	54	59	54	54	30	3	3	2	2	2
	40	55	36	55	32	55	27	55	23	55	19	55	14	55	9	55	8	40	2	2	2	2	2
	50	55	46	55	41	55	37	55	33	55	28	55	24	55	20	55	15	50	1	1	1	1	1
86	0	56	56	55	52	55	48	55	43	55	3	55	35	55	31	55	27	0	4	4	4	4	4
	10	56	5	56	1	55	57	55	53	55	4	55	45	55	41	55	37	10	3	3	3	3	3
	20	56	14	56	11	56	7	56	3	55	59	55	55	55	52	55	43	20	3	3	3	3	3
	30	56	24	56	20	56	16	56	13	56	9	56	5	56	5	55	58	30	2	2	2	2	2
	40	56	33	56	29	56	26	56	23	56	19	56	15	56	12	56	8	40	2	1	1	1	1
	50	56	42	56	39	56	36	56	32	56	29	56	26	56	22	56	19	50	1	1	1	1	1
87	0	56	52	56	49	56	46	56	43	56	40	56	37	56	34	56	30	0	3	3	3	3	3
	10	57	2	56	59	56	56	56	53	56	50	56	47	56	44	56	41	10	3	3	2	2	2
	20	57	11	57	0	57	5	57	3	57	0	56	57	56	54	56	51	20	2	2	2	2	2
	30	57	20	57	18	57	15	57	12	57	10	57	7	57	4	57	2	30	2	2	2	2	2
	40	57	29	57	27	57	25	57	22	57	20	57	17	57	15	57	12	40	1	1	1	1	1
	50	57	39	57	36	57	34	57	32	57	30	57	27	57	24	57	23	50	1	1	1	1	1
88	0	57	49	57	47	57	45	57	43	57	41	57	39	57	36	57	34	0	2	2	2	2	2
	10	57	58	57	56	57	54	57	52	57	50	57	49	57	47	57	45	10	2	2	2	2	2
	20	58	7	58	6	58	4	58	2	58	0	57	59	57	57	55	53	20	1	1	1	1	1
	30	58	17	58	15	58	14	58	12	58	10	58	9	58	7	58	6	30	1	1	1	1	1
	40	58	26	58	25	58	23	58	22	58	20	58	19	58	18	58	16	40	1	1	1	1	1
	50	58	35	58	34	58	33	58	32	58	30	58	29	58	28	58	27	50	1	1	1	1	1
89	0	59	45	58	44	58	43	58	42	58	41	58	40	58	39	58	38	0	1	1	1	1	1
	10	59	55	58	54	58	53	58	52	58	51	58	50	58	49	58	49	10	1	1	1	1	1
	20	59	4	59	3	59	2	59	1	59	0	59	0	59	59	58	59	20	1	1	1	1	1
	30	59	13	59	13	59	12	59	11	59	11	59	11	59	10	59	10	30	1	1	1	1	1
	40	59	22	59	22	59	21	59	21	59	21	59	21	59	20	59	20	40	1	1	1	1	1
	50	59	32	59	32	59	31	59	31	59	31	59	31	59	31	59	31	50	1	1	1	1	1



TABLE XIX.

121

LOGARITHMS.

M	S	Apparent Altitude of β 's centre.										TABLE C. Correction for Seconds of Parallax. Add.	
		80°	81°	82°	83°	84°	85°	86°	87°	88°	89°	S.	Cor.
54	0	2283	2283	2283	2283	2283	2283	2283	2283	2283	2283	0	12
	10	2270	2270	2270	2270	2269	2269	2269	2269	2269	2269	1	11
	20	2256	2256	2256	2256	2256	2256	2256	2256	2256	2256	2	9
	30	2243	2243	2242	2242	2242	2242	2242	2242	2242	2242	3	8
	40	2229	2229	2229	2229	2229	2229	2229	2229	2229	2229	4	7
	50	2216	2216	2216	2215	2215	2215	2215	2215	2215	2215	5	5
55	0	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202	6	4
	10	2189	2189	2189	2189	2189	2189	2189	2189	2188	2188	7	3
	20	2176	2175	2175	2175	2175	2175	2175	2175	2175	2175	8	1
	30	2162	2162	2162	2162	2162	2162	2162	2162	2162	2162	9	0
	40	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149		
	50	2136	2136	2136	2136	2136	2136	2135	2135	2135	2135		
56	0	2123	2123	2122	2122	2122	2122	2122	2122	2122	2122	0	12
	10	2109	2109	2109	2109	2109	2109	2109	2109	2109	2109	1	11
	20	2096	2096	2096	2096	2096	2096	2096	2096	2096	2096	2	9
	30	2083	2083	2083	2083	2083	2083	2083	2083	2083	2083	3	8
	40	2070	2070	2070	2070	2070	2070	2070	2070	2070	2070	4	7
	50	2057	2057	2057	2057	2057	2057	2057	2057	2057	2057	5	5
57	0	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	6	4
	10	2032	2031	2031	2031	2031	2031	2031	2031	2031	2031	7	3
	20	2019	2019	2019	2018	2018	2018	2018	2018	2018	2018	8	2
	30	2006	2006	2006	2006	2006	2006	2006	2005	2005	2005	9	0
	40	1993	1993	1993	1993	1993	1993	1993	1993	1993	1993		
	50	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980		
58	0	1968	1968	1967	1967	1967	1967	1967	1967	1967	1967	0	12
	10	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955	1	11
	20	1942	1942	1942	1942	1942	1942	1942	1942	1942	1942	2	9
	30	1930	1930	1930	1930	1929	1929	1929	1929	1929	1929	3	8
	40	1917	1917	1917	1917	1917	1917	1917	1917	1917	1917	4	7
	50	1905	1905	1904	1904	1904	1904	1904	1904	1904	1904	5	6
59	0	1892	1892	1892	1892	1892	1892	1892	1892	1892	1892	6	4
	10	1880	1880	1880	1879	1879	1879	1879	1879	1879	1879	7	3
	20	1867	1867	1867	1867	1867	1867	1867	1867	1867	1867	8	2
	30	1855	1855	1855	1855	1855	1855	1855	1855	1855	1855	9	1
	40	1843	1842	1842	1842	1842	1842	1842	1842	1842	1842		
	50	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830		
60	0	1818	1818	1818	1818	1818	1818	1818	1818	1818	1818	0	12
	10	1806	1806	1806	1806	1805	1805	1805	1805	1805	1805	1	11
	20	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793	2	10
	30	1781	1781	1781	1781	1781	1781	1781	1781	1781	1781	3	8
	40	1769	1769	1769	1769	1769	1769	1769	1769	1769	1769	4	7
	50	1757	1757	1757	1757	1757	1757	1757	1757	1757	1757	5	6
61	0	1745	1745	1745	1745	1745	1745	1745	1745	1745	1745	6	5
	10	1733	1733	1733	1733	1733	1733	1733	1733	1733	1733	7	4
	20	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721	8	3
	30	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709	9	1
M	S	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°		

TABLE XX.

Corr Tab. 19		Apparent Distance.											
		10°		11°		12°		13°		14°		15°	
		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.
M	M	"	"	"	"	"	"	"	"	"	"	"	"
0	120	196	178	179	161	166	148	154	136	144	126	135	117
1	119	190	172	174	156	161	143	149	131	140	122	131	113
2	118	184	166	169	151	156	138	145	127	136	118	127	109
3	117	178	160	164	146	151	133	141	123	132	114	124	106
4	116	173	155	159	141	147	129	136	118	128	110	121	102
5	115	167	149	154	136	142	124	131	114	124	106	116	98
6	114	162	144	149	131	138	120	128	110	120	102	113	95
7	113	157	139	144	126	133	115	124	106	116	98	109	91
8	112	152	134	139	121	129	111	120	102	113	94	106	88
9	111	146	128	133	117	125	107	116	98	109	91	103	85
10	110	142	124	130	112	121	103	112	94	105	87	99	81
11	109	137	119	126	108	116	98	109	91	102	84	96	78
12	108	132	114	121	103	112	94	105	87	99	81	93	75
13	107	127	109	117	99	109	91	101	83	95	77	90	72
14	106	123	105	113	95	105	87	98	80	92	74	87	69
15	105	118	100	109	91	101	83	94	76	89	71	84	66
16	104	114	96	105	87	97	79	91	73	86	68	81	63
17	103	109	91	101	83	94	76	88	70	83	65	78	60
18	102	105	87	97	79	90	72	85	67	80	62	75	57
19	101	101	83	93	75	87	69	81	63	77	59	73	54
20	100	97	79	90	72	84	66	78	60	74	56	70	52
21	99	93	75	86	68	80	62	76	57	71	53	68	50
22	98	89	71	83	65	77	59	73	55	69	51	65	47
23	97	86	68	79	61	74	56	70	52	66	48	63	45
24	96	82	64	76	58	71	53	67	49	63	45	60	42
25	95	79	61	73	55	68	50	64	46	61	43	58	40
26	94	75	57	70	52	65	47	62	44	58	40	56	38
27	93	72	54	67	49	63	44	59	41	56	38	53	35
28	92	69	51	64	46	60	42	57	39	54	36	51	33
29	91	66	48	61	43	57	39	54	36	52	34	49	31
30	90	63	45	58	40	55	37	52	34	49	31	47	29
31	89	60	42	56	38	53	35	50	32	47	29	45	27
32	88	57	39	53	35	50	32	48	30	45	27	44	26
33	87	54	36	51	33	48	30	46	28	44	26	42	24
34	86	51	33	48	30	46	28	44	26	42	24	40	22
35	85	49	31	46	28	44	26	42	24	40	22	38	20
36	84	46	28	44	26	42	24	40	22	38	20	37	19
37	83	44	26	42	24	40	22	38	20	37	19	35	17
38	82	42	24	40	22	38	20	36	18	35	17	34	16
39	81	40	22	38	20	36	18	35	17	33	16	32	14
40	80	38	20	36	18	34	16	33	15	32	14	31	13
41	79	36	18	34	16	32	14	32	14	31	13	30	12
42	78	34	16	33	15	31	13	30	12	29	11	29	11
43	77	32	14	31	13	30	12	29	11	28	10	27	9
44	76	31	13	29	11	29	11	28	10	27	9	26	8
45	75	29	11	28	10	27	9	27	9	26	8	25	7
46	74	28	10	27	9	26	8	25	7	25	7	24	6
47	73	26	8	26	8	25	7	24	6	24	6	24	6
48	72	25	7	24	6	24	6	23	5	23	5	23	5
49	71	24	6	23	5	23	5	23	5	22	4	22	4
50	70	23	5	22	4	22	4	22	4	21	3	21	3
51	68	21	3	21	3	21	3	20	2	20	2	20	2
52	65	19	1	19	1	19	1	19	1	19	1	19	1
53	63	18	0	18	0	18	0	18	0	18	0	18	0
54	60												
		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.
		10°		11°		12°		13°		14°		15°	

TABLE XX.

Corr. Tab. 19.		Apparent Distance.															
		16°		17°		18°		19°		20°		21°		22°			
Corr Tab. 19. + 2 Cr.		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.		
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"		
0	120	127	109	121	103	116	97	109	91	104	86	100	82	96	78		
1	119	124	106	117	99	111	93	106	88	101	83	97	79	93	75		
2	118	120	102	114	96	108	90	103	85	99	81	94	76	91	73		
3	117	117	99	111	93	105	87	100	82	96	78	92	74	88	70		
4	116	113	95	107	89	102	84	97	79	93	75	89	71	85	68		
5	115	110	92	104	86	99	81	95	77	90	72	87	69	83	65		
6	114	107	89	101	83	96	78	92	74	88	70	84	66	81	63		
7	113	103	85	98	80	93	75	89	71	85	67	82	64	79	61		
8	112	100	82	95	77	91	73	86	68	83	65	79	61	76	58		
9	111	97	79	92	74	88	70	84	66	80	62	77	59	74	56		
10	110	94	76	89	71	85	67	81	63	78	60	75	57	72	54		
11	109	91	73	86	68	82	64	79	61	76	58	73	55	70	52		
12	108	88	70	84	66	80	62	76	58	73	55	70	52	68	50		
13	107	85	67	81	63	77	59	74	56	71	53	68	50	66	48		
14	106	82	64	78	60	75	57	72	54	69	51	66	48	64	46		
15	105	80	62	76	58	72	54	69	51	67	49	64	46	62	44		
16	104	77	59	73	55	70	52	67	49	64	46	62	44	60	42		
17	103	74	56	71	53	68	50	65	47	62	44	60	42	58	40		
18	102	72	54	69	50	66	47	63	45	60	42	58	40	56	38		
19	101	69	51	66	48	63	45	61	43	58	40	56	38	54	36		
20	100	67	49	64	46	61	43	59	41	56	38	54	36	53	35		
21	99	64	46	61	43	59	41	57	39	54	36	53	35	51	33		
22	98	62	44	59	41	57	39	55	37	53	35	51	33	49	31		
23	97	60	42	57	39	55	37	53	35	51	33	49	31	48	30		
24	96	57	39	55	37	53	35	51	33	49	31	47	29	46	28		
25	95	55	37	53	35	51	33	49	31	47	29	46	28	44	26		
26	94	53	35	51	33	49	31	47	29	46	28	44	26	42	24		
27	93	51	33	49	31	47	29	46	28	43	26	43	25	40	22		
28	92	49	31	47	29	45	27	44	26	43	25	41	23	39	21		
29	91	47	29	45	27	44	26	42	24	41	23	40	22	38	20		
30	90	45	27	44	25	42</											

Corr. Tab. 19.		Apparent Distance.															
Corr. Tab. 19. + 2 Cr.		23°		24°		25°		26°		27°		28°		29°		30°	
		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.
M	M	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	92	74	89	71	85	67	82	64	80	62	77	59	73	57	72	54
1	119	90	72	86	65	83	65	80	62	78	60	75	57	73	55	71	53
2	118	87	69	84	66	81	63	78	60	76	58	73	55	71	53	69	51
3	117	85	67	82	64	79	61	76	58	74	56	71	53	69	51	67	49
4	116	82	64	79	61	77	58	74	56	72	54	69	51	67	49	65	47
5	115	80	62	77	59	75	57	72	54	70	52	68	50	66	48	64	46
6	114	78	60	75	57	73	55	70	52	68	50	66	48	64	46	62	44
7	113	76	58	73	55	71	53	68	50	66	48	64	46	62	44	60	42
8	112	74	56	71	53	69	51	66	48	64	46	62	44	61	43	59	41
9	111	71	53	69	51	67	49	65	47	63	45	61	43	59	41	57	39
10	110	69	51	67	49	65	47	63	45	61	43	59	41	57	39	56	38
11	109	67	49	65	47	63	45	61	43	59	41	57	39	56	38	54	36
12	108	65	47	63	45	61	43	59	41	57	39	56	38	54	36	53	35
13	107	63	45	61	43	59	41	58	40	56	38	54	36	53	35	51	33
14	106	61	43	59	41	58	40	56	38	54	36	53	35	51	33	50	32
15	105	60	42	58	40	56	38	54	36	53	35	51	33	50	32	49	31
16	104	58	40	56	38	54	36	53	35	51	33	50	32	48	30	47	29
17	103	56	38	54	36	53	35	51	33	50	32	48	30	47	29	46	28
18	102	54	36	53	35	51	33	50	32	48	30	47	29	46	28	45	27
19	101	53	35	51	33	49	31	48	30	47	29	46	28	44	26	43	25
20	100	51	33	49	31	48	30	47	29	45	27	44	26	43	25	42	24
21	99	49	31	48	30	46	28	45	27	44	26	43	25	42	24	41	23
22	98	48	30	46	28	45	27	44	26	43	25	42	24	41	23	40	22
23	97	46	28	45	27	44	26	42	24	41	23	40	22	40	22	39	21
24	96	45	27	43	25	42	24	41	23	40	22	39	21	38	20	38	20
25	95	43	25	42	24	41	23	40	22	39	21	38	20	37	19	37	19
26	94	42	24	41	23	40	22	39	21	38	20	37	19	36	18	35	17
27	93	41	22	39	21	38	20	37	19	36	18	35	17	35	17	34	16
28	92	39	21	38	20	37	19	36	18	34	16	33	15	34	16	33	15
29	91	38	20	37	19	36	18	35	17	34	16	34	16	33	15	33	15
30	90	37	19	36	18	35	17	34	16	33	15	33	15	32	14	32	14
31	89	35	17	34	16	34	16	33	15	32	14	32	14	31	13	31	13
32	88	34	16	33	15	33	16	32	14	31	13	31	13	30	12	30	12
33	87	33	15	32	14	32	14	31	13	30	12	30	12	29	11	29	11
34	86	32	14	31	13	31	13	30	12	30	12	29	11	29	11	28	10
35	85	31	13	30	12	30	12	29	11	29	11	28	10	28	10	27	9
36	84	30	12	29	11	29	11	28	10	28	10	27	9	27	9	27	9
37	83	29	11	28	10	28	10	27	9	27	9	27	9	26	8	26	8
38	82	28	10	27	9	27	9	27	9	26	8	26	8	26	8	25	7
39	81	27	9	27	9	26	8	26	8	26	8	26	7	25	7	25	7
40	80	26	8	26	8	25	7	25	7	25	7	25	7	24	6	24	6
41	79	25	7	25	7	25	7	24	6	24	6	24	6	24	6	23	5
42	78	25	7	24	6	24	6	24	6	24	6	23	5	23	5	23	5
43	77	24	6	24	6	23	5	23	5	23	5	23	5	23	5	22	4
44	76	23	5	23	5	23	5	23	5	22	4	22	4	22	4	22	4
45	75	23	5	22	4	23	4	22	4	22	4	22	4	22	4	21	3
46	74	22	4	22	4	22	4	22	4	21	3	21	3	21	3	21	3
47	73	21	3	21	3	21	3	21	3	21	3	21	3	21	3	20	2
48	72	21	3	21	3	21	3	21	3	20	2	20	2	20	2	20	2
49	71	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
50	70	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
52	68	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
55	65	19	1	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.
		23°		24°		25°		26°		27°		28°		29°		30°	

TABLE XX.

Corr. Tab. 19.		Apparent Distance.															
Corr. Tab. 19 + 2 Cr		31°		32°		33°		34°		35°		36°		37°		38°	
M	M	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor	Tab. 19.	Tab. 19. + 2Cor
0	120	70	52	68	50	66	48	65	47	63	45	61	43	60	42	58	40
1	119	69	51	67	49	65	47	63	45	61	43	59	42	58	40	57	39
2	118	67	49	65	47	63	45	62	44	60	42	58	40	57	39	56	38
3	117	65	47	63	45	62	44	60	42	58	40	57	39	56	38	54	36
4	116	64	46	62	44	60	42	59	41	57	39	56	38	54	36	53	35
5	115	62	44	60	42	59	41	57	39	56	38	54	36	53	35	52	34
6	114	60	42	59	41	57	39	56	38	54	36	53	35	52	34	51	33
7	113	59	41	57	39	56	38	54	36	53	35	52	34	51	33	49	31
8	112	57	39	56	38	54	36	53	35	52	34	50	32	49	31	48	30
9	111	56	38	54	36	53	35	52	34	50	32	49	31	48	30	47	29
10	110	54	36	53	35	52	34	50	32	49	31	48	30	47	29	46	28
11	109	53	35	52	34	50	32	49	31	48	30	47	29	46	28	45	27
12	108	51	33	50	32	49	31	48	30	47	29	46	28	45	27	44	26
13	107	50	32	49	31	48	30	47	29	46	28	45	27	44	26	43	25
14	106	49	31	48	30	46	28	45	27	44	26	43	25	43	25	42	24
15	105	47	29	46	28	45	27	44	26	43	25	42	24	41	23	41	23
16	104	46	28	45	27	44	26	43	25	42	24	41	23	40	22	40	22
17	103	45	27	44	26	43	25	42	24	41	23	40	22	39	21	39	21
18	102	44	26	43	25	42	24	41	23	40	22	39	21	38	20	38	20
19	101	43	24	41	23	41	23	40	22	39	21	38	20	37	19	37	19
20	100	41	23	40	22	39	21	39	21	38	20	37	19	37	19	36	18
21	99	40	22	39	21	38	20	38	20	37	19	36	18	36	18	35	17
22	98	39	21	38	20	37	19	37	19	36	18	35	17	35	17	34	16
23	97	38	20	37	19	36	18	36	18	35	17	34	16	34	16	33	15
24	96	37	19	36	18	35	17	35	17	34	16	33	15	33	15	32	14
25	95	36	18	35	17	34	16	34	16	33	15	33	15	32	14	32	14
26	94	35	17	34	16	34	16	33	15	32	14	32	14	31	13	31	13
27	93	34	16	33	15	33	15	32	14	32	14	31	13	31	13		

TABLE XX.

Corr. Tab. 19.		Apparent Distance.															
		39°		40°		41°		42°		43°		44°		45°		46°	
Corr. Tab. 19 + 2 Cr.		Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.	Tab. 19.	Tab. 19. + 2 Cor.
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	57	39	56	37	54	36	53	35	52	34	51	33	49	31	48	30
1	119	56	38	54	36	53	35	52	34	51	33	49	31	48	30	47	29
2	118	54	36	53	34	52	34	51	33	49	31	48	30	47	29	46	28
3	117	53	34	52	34	51	33	49	31	48	30	47	29	46	28	45	27
4	116	52	34	51	34	49	31	48	30	47	29	46	28	45	27	44	26
5	115	51	33	49	31	48	30	47	29	46	28	45	27	44	26	43	25
6	114	49	31	48	30	47	29	46	28	45	27	44	26	43	25	42	24
7	113	48	30	47	29	46	28	45	27	44	26	43	25	42	24	41	23
8	112	47	29	46	28	45	27	44	26	43	25	42	24	41	23	40	22
9	111	46	28	45	27	44	26	43	25	42	24	41	23	40	22	39	21
10	110	45	27	44	26	43	25	42	24	41	23	40	22	39	21	38	20
11	109	44	26	43	25	42	24	41	23	40	22	39	21	38	20	37	19
12	108	43	25	42	24	41	23	40	22	39	21	38	20	37	19	36	18
13	107	42	24	41	23	40	22	39	21	38	20	37	19	36	18	35	17
14	106	41	23	40	22	39	21	38	20	37	19	36	18	35	17	34	16
15	105	40	22	39	21	38	20	37	19	36	18	35	17	34	16	33	15
16	104	39	21	38	20	37	19	36	18	35	17	34	16	33	15	32	14
17	103	38	20	37	19	36	18	35	17	34	16	33	15	32	14	31	13
18	102	37	19	36	18	35	17	34	16	33	15	32	14	31	13	30	12
19	101	36	18	35	17	34	16	33	15	32	14	31	13	30	12	29	11
20	100	35	17	34	16	33	15	32	14	31	13	30	12	29	11	28	10
21	99	34	16	33	15	32	14	31	13	30	12	29	11	28	10	27	9
22	98	34	16	33	15	32	14	31	13	30	12	29	11	28	10	27	9
23	97	33	15	32	14	31	13	30	12	29	11	28	10	27	9	26	8
24	96	32	14	31	13	30	12	29	11	28	10	27	9	26	8	25	7
25	95	31	13	30	12	29	11	28	10	27	9	26	8	25	7	24	6
26	94	30	12	29	11	28	10	27	9	26	8	25	7	24	6	23	5
27	93	30	12	29	11	28	10	27	9	26	8	25	7	24	6	23	5
28	92	29	11	28	10	27	9	26	8	25	7	24	6	23	5	22	4
29	91	28	10	27	9	26	8	25	7	24	6	23	5	22	4	21	3
30	90	27	9	26	8	25	7	24	6	23	5	22	4	21	3	20	2
31	89	26	8	25	7	24	6	23	5	22	4	21	3	20	2	19	1
32	88	26	8	25	7	24	6	23	5	22	4	21	3	20	2	19	1
33	87	25	7	24	6	23	5	22	4	21	3	20	2	19	1	18	0
34	86	25	7	24	6	23	5	22	4	21	3	20	2	19	1	18	0
35	85	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
36	84	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
37	83	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
38	82	23	5	22	4	21	3	20	2	19	1	18	0	17	0	16	0
39	81	23	5	22	4	21	3	20	2	19	1	18	0	17	0	16	0
40	80	22	4	21	3	20	2	19	1	18	0	17	0	16	0	15	0
41	79	22	4	21	3	20	2	19	1	18	0	17	0	16	0	15	0
42	78	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
43	77	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
44	76	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
45	75	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
46	74	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
47	73	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
48	72	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
49	71	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
50	70	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
51	69	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
52	68	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
53	67	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
54	66	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
55	65	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
56	64	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
57	63	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
58	62	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
59	61	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
60	60	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0

TABLE XX.

127

Corr. Tab. 19		Apparent Distance.															
Corr Tab. 19. +2Cr.		47°		48°		49°		50°		51°		52°		53°		54°	
M	M	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor
0	120	47	29	46	28	45	27	44	26	43	25	42	24	41	23	40	22
1	119	46	28	45	27	44	26	43	25	42	24	41	23	40	22	39	21
2	118	45	27	44	26	43	25	42	24	41	23	40	22	39	21	38	20
3	117	44	26	43	25	42	24	41	23	40	22	39	21	38	20	37	19
4	116	44	26	43	25	42	24	41	23	40	22	39	21	38	20	37	19
5	115	43	25	42	24	41	23	40	22	39	21	38	20	37	19	36	18
6	114	42	24	41	23	40	22	39	21	38	20	37	19	36	18	35	17
7	113	41	23	40	22	39	21	38	20	37	19	36	18	35	17	34	16
8	112	40	22	39	21	38	20	37	19	36	18	35	17	34	16	33	15
9	111	39	21	38	20	37	19	36	18	35	17	34	16	33	15	32	14
10	110	38	20	37	19	36	18	35	17	34	16	33	15	32	14	31	13
11	109	38	20	37	19	36	18	35	17	34	16	33	15	32	14	31	13
12	108	37	19	36	18	35	17	34	16	33	15	32	14	31	13	30	12
13	107	36	18	35	17	34	16	33	15	32	14	31	13	30	12	29	11
14	106	35	17	34	16	33	15	32	14	31	13	30	12	29	11	28	10
15	105	34	16	33	15	32	14	31	13	30	12	29	11	28	10	27	9
16	104	34	16	33	15	32	14	31	13	30	12	29	11	28	10	27	9
17	103	33	15	32	14	31	13	30	12	29	11	28	10	27	9	26	8
18	102	32	14	31	13	30	12	29	11	28	10	27	9	26	8	25	7
19	101	31	13	30	12	29	11	28	10	27	9	26	8	25	7	24	6
20	100	31	13	30	12	29	11	28	10	27	9	26	8	25	7	24	6
21	99	30	12	29	11	28	10	27	9	26	8	25	7	24	6	23	5
22	98	30	12	29	11	28	10	27	9	26	8	25	7	24	6	23	5
23	97	29	11	28	10	27	9	26	8	25	7	24	6	23	5	22	4
24	96	29	11	28	10	27	9	26	8	25	7	24	6	23	5	22	4
25	95	28	10	27	9	26	8	25	7	24	6	23	5	22	4	21	3
26	94	27	9	26	8	25	7	24	6	23	5	22	4	21	3	20	2
27	93	27	9	26	8	25	7	24	6	23	5	22	4	21	3	20	2
28	92	26	8	25	7	24	6	23	5	22	4	21	3	20	2	19	1
29	91	26	8	25	7	24	6	23	5	22	4	21	3	20	2	19	1
30	90	25	7	24	6	23	5	22	4	21	3	20	2	19	1	18	0
31	89	25	7	24	6	23	5	22	4	21	3	20	2	19	1	18	0
32	88	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
33	87	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
34	86	24	6	23	5	22	4	21	3	20	2	19	1	18	0	17	0
35	85	23	5	22	4	21	3	20	2	19	1	18	0	17	0	16	0
36	84	23	5	22	4	21	3	20	2	19	1	18	0	17	0	16	0
37	83	22	4	21	3	20	2	19	1	18	0	17	0	16	0	15	0
38	82	22	4	21	3	20	2	19	1	18	0	17	0	16	0	15	0
39	81	22	4	21	3	20	2	19	1	18	0	17	0	16	0	15	0
40	80	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
41	79	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
42	78	21	3	20	2	19	1	18	0	17	0	16	0	15	0	14	0
43	77	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
44	76	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
45	75	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
46	74	20	2	19	1	18	0	17	0	16	0	15	0	14	0	13	0
47	73	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
48	72	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
49	71	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
50	70	19	1	18	0	17	0	16	0	15	0	14	0	13	0	12	0
51	69	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
52	68	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
53	67	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0
54	66	18	0	17	0	16	0	15	0	14	0	13	0	12	0	11	0

TABLE XX.

Corr Tab. 19.		Apparent Distance.															
Corr. Tab. 19. +2Cr		55°		56°		57°		58°		59°		60°		65°		70°	
M	M.	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor
0	120	40	22	39	21	38	20	38	20	37	19	36	18	33	15	29	11
1	119	39	21	38	20	38	20	37	19	36	18	36	18	32	14	29	11
2	118	39	21	38	20	37	19	36	18	36	18	35	17	32	14	29	11
3	117	38	20	37	19	36	18	36	18	35	17	34	16	31	13	28	10
4	116	37	19	36	18	36	18	35	17	34	16	34	16	31	13	28	10
5	115	36	18	36	18	35	17	34	16	34	16	33	15	30	12	28	10
6	114	36	18	35	17	35	17	34	16	33	15	33	15	30	12	27	9
7	113	35	17	35	17	34	16	33	15	33	15	32	14	29	11	27	9
8	112	35	17	34	16	33	15	33	15	32	14	32	14	29	11	27	9
9	111	34	16	33	15	33	15	32	14	32	14	31	13	29	11	26	8
10	110	33	15	33	15	32	14	32	14	31	13	31	13	28	10	26	8
11	109	33	15	32	14	32	14	31	13	31	13	30	12	28	10	26	8
12	108	32	14	32	14	31	13	31	13	30	12	30	12	27	9	26	7
13	107	31	13	31	13	31	13	30	12	30	12	29	11	27	9	26	7
14	106	31	13	30	12	30	12	30	12	29	11	29	11	27	9	25	7
15	105	30	12	30	12	29	11	29	11	29	11	28	10	26	8	24	6
16	104	30	12	29	11	29	11	29	11	28	10	28	10	26	8	24	6
17	103	29	11	29	11	28	10	28	10	28	10	27	9	26	8	24	6
18	102	29	11	28	10	28	10	28	10	27	9	27	9	25	7	24	6
19	101	28	10	28	10	28	10	27	9	27	9	26	8	25	7	23	5
20	100	28	10	27	9	27	9	27	9	26	8	26	8	25	7	23	5
21	99	27	9	27	9	27	9	26	8	26	8	26	8	24	6	23	5
22	98	27	9	26	8	26	8	26	8	26	8	25	7	24	6	23	5
23	97	26	8	26	8	26	8	25	7	25	7	25	7	24	6	22	4
24	96	26	8	26	8	25	7	25	7	25	7	25	7	23	5	22	4
25	95	25	7	25	7	25	7	25	7	24	6	24	6	23	5	22	4
26	94	25	7	25	7	25	7	24	6	24	6	24	6	23	5	22	4
27	93	25	7	24	6	24	6	24	6	24	6	23	5	22	4	21	3
28	92	24	6	24	6	24	6	24	6	23	5	23	5	22	4	21	3
29	91	24	6	24	6	23	5	23	5	23	5	23	5	22	4	21	3
30	90	23	5	23	5	23	5	23	5	23	5	23	5	22	4	21	3
31	89	23	5	23	5	23	5	23	5	22	4	22	4	21	3	21	3
32	88	23	5	23	5	22	4	22	4	22	4	22	4	21	3	20	2
33	87	22	4	22	4	22	4	22	4	22	4	22	4	21	3	20	2
34	86	22	4	22	4	22	4	22	4	22	4	21	3	21	3	20	2
35	85	22	4	22	4	22	4	21	3	21	3	21	3	21	3	20	2
36	84	22	4	21	3	21	3	21	3	21	3	21	3	20	2	20	2
37	83	21	3	21	3	21	3	21	3	21	3	21	3	20	2	20	2
38	82	21	3	21	3	21	3	21	3	21	3	20	2	20	2	20	2
39	81	21	3	21	3	20	2	20	2	20	2	20	2	20	2	19	1
40	80	20	2	20	2	20	2	20	2	20	2	20	2	20	2	19	1
41	79	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
42	78	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
43	77	20	2	20	2	20	2	20	2	20	2	19	1	19	1	19	1
44	76	20	2	20	2	19	1	19	1	19	1	19	1	19	1	19	1
45	75	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
46	74	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
47	73	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
48	72	19	1	19	1	19	1	19	1	19	1	19	1	19	1	18	0
49	71	19	1	19	1	19	1	19	1	19	1	19	1	18	0	18	0
50	70	19	1	19	1	19	1	19	1	19	1	19	1	18	0	18	0
51	69	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
52	68	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
53	67	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
54	66	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
55	65	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
56	64	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
57	63	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
58	62	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
59	61	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor	Tab. 19	Tab. 19. +2Cor
		55°		56°		57°		58°		59°		60°		65°		70°	

TABLE XX.

129

Corr.		Apparent Distance																			
Tab.19		75°		80°		85°		90°		95°		100°		105°		110°		115°		120°	
Cor.	Tab.19	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor	Tab.19	+2Cor
M	M	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	1	26	8	24	6	21	3	18	0	3	21	6	24	8	26	11	29	15	33	18	36
1	11	26	8	23	5	21	3	18	0	3	21	5	23	8	26	11	29	14	32	18	36
2	18	26	8	23	5	21	3	18	0	3	21	5	23	8	26	11	29	14	32	17	35
3	117	26	8	23	5	20	2	18	0	2	20	5	23	8	26	10	28	13	31	16	34
4	116	25	7	23	5	20	2	18	0	2	20	5	23	7	25	10	28	13	31	16	34
5	115	25	7	23	5	20	2	18	0	2	20	5	23	7	25	10	28	12	30	15	33
6	114	25	7	22	4	20	2	18	0	2	20	4	22	7	25	9	27	12	30	15	33
7	113	25	7	22	4	20	2	18	0	2	20	4	22	7	25	9	27	11	29	14	32
8	112	24	6	22	4	20	2	18	0	2	20	4	22	6	24	9	27	11	29	14	32
9	111	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	11	29	13	31
10	110	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	10	28	13	31
11	109	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	10	28	12	30
12	108	23	5	22	4	20	2	18	0	2	20	4	22	5	23	7	25	9	27	12	30
13	107	23	5	21	3	20	2	18	0	2	20	3	21	5	23	7	25	9	27	11	29
14	106	23	5	21	3	21	2	18	0	2	20	3	21	5	23	7	25	9	27	11	29
15	105	23	5	21	3	20	2	18	0	2	20	3	21	5	23	6	24	8	26	10	28
16	104	23	5	21	3	19	1	18	0	1	19	3	21	5	23	6	24	8	26	10	28
17	103	22	4	21	3	19	1	18	0	1	19	3	21	4	22	6	24	8	26	9	27
18	102	22	4	21	3	19	1	18	0	1	19	3	21	4	22	6	24	7	25	9	27
19	101	22	4	21	3	19	1	18	0	1	19	3	21	4	22	5	23	7	25	8	26
20	100	22	4	20	2	19	1	18	0	1	19	2	20	4	22	5	23	7	25	8	26
21	99	22	4	20	2	19	1	18	0	1	19	2	20	4	22	5	23	6	24	8	26
22	98	21	3	20	2	19	1	18	0	1	19	2	20	3	21	5	23	6	24	7	25
23	97	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	6	24	7	25
24	96	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	7	25
25	95	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	6	24
26	94	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	6	24
27	93	21	3	20	2	19	1	18	0	1	19	2	20	3	21	3	21	4	22	5	23
28	92	20	2	20	2	19	1	18	0	1	19	2	20	2	20	3	21	4	22	5	23
29	91	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	4	22	5	23
30	90	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	4	22	5	23
31	89	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	3	21	4	22
32	88	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	4	22
33	87	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	4	22
34	86	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	3	21
35	85	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	3	21	3	21
36	84	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	3	21	3	21
37	83	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	3	21	3	21
38	82	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	3	21	2	20
39	81	19	1	19	1	19	0	18	0	0	18	1	19	1	19	1	19	2	20	2	20
40	80	19	1	19	1	18	0	18	0	0	18	1	19	1	19	1	19	2	20	2	20
41	79	19	1	19	1	18	0	18	0	0	18	1	19	1	19	1	19	1	19	2	20
42	78	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	2	20
43	77	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
44	76	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
45	75	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
46	74	18	0	18	0	18	0	18	0	0	18	0	18	0	18	1	19	1	19	1	19
47	73	18	0	18	0	18	0	18	0	0	18	0	18	0	18	1	19	1	19	1	19
48	72	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	1	19	1	19
49	71	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	1	19
50	70	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	1	19
51	69	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
52	68	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
53	67	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
54	66	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18

For turning Degrees and Minutes into Time, and the contrary.

D	HM	D	HM	D	HM	D	HM	D	HM	D	HM
M	MS	M	MS	M	MS	M	MS	M	MS	M	MS
1	0. 4	61	4. 4	121	8. 4	181	12. 4	241	16. 4	301	20. 4
2	0. 8	62	4. 8	122	8. 8	182	12. 8	242	16. 8	302	20. 8
3	0.12	63	4.12	123	8.12	183	12.12	243	16.12	303	20.12
4	0.16	64	4.16	124	8.16	184	12.16	244	16.16	304	20.16
5	0.20	65	4.20	125	8.20	185	12.20	245	16.20	305	20.20
6	0.24	66	4.24	126	8.24	186	12.24	246	16.24	306	20.24
7	0.28	67	4.28	127	8.28	187	12.28	247	16.28	307	20.28
8	0.32	68	4.32	128	8.32	188	12.32	248	16.32	308	20.32
9	0.36	69	4.36	129	8.36	189	12.36	249	16.36	309	20.36
10	0.40	70	4.40	130	8.40	190	12.40	250	16.40	310	20.40
11	0.44	71	4.44	131	8.44	191	12.44	251	16.44	311	20.44
12	0.48	72	4.48	132	8.48	192	12.48	252	16.48	312	20.48
13	0.52	73	4.52	133	8.52	193	12.52	253	16.52	313	20.52
14	0.56	74	4.56	134	8.56	194	12.56	254	16.56	314	20.56
15	1. 0	75	5. 0	135	9. 0	195	13. 0	255	17. 0	315	21. 0
16	1. 4	76	5. 4	136	9. 4	196	13. 4	256	17. 4	316	21. 4
17	1. 8	77	5. 8	137	9. 8	197	13. 8	257	17. 8	317	21. 8
18	1.12	78	5.12	138	9.12	198	13.12	258	17.12	318	21.12
19	1.16	79	5.16	139	9.16	199	13.16	259	17.16	319	21.16
20	1.20	80	5.20	140	9.20	200	13.20	260	17.20	320	21.20
21	1.24	81	5.24	141	9.24	201	13.24	261	17.24	321	21.24
22	1.28	82	5.28	142	9.28	202	13.28	262	17.28	322	21.28
23	1.32	83	5.32	143	9.32	203	13.32	263	17.32	323	21.32
24	1.36	84	5.36	144	9.36	204	13.36	264	17.36	324	21.36
25	1.40	85	5.40	145	9.40	205	13.40	265	17.40	325	21.40
26	1.44	86	5.44	146	9.44	206	13.44	266	17.44	326	21.44
27	1.48	87	5.48	147	9.48	207	13.48	267	17.48	327	21.48
28	1.52	88	5.52	148	9.52	208	13.52	268	17.52	328	21.52
29	1.56	89	5.56	149	9.56	209	13.56	269	17.56	329	21.56
30	2. 0	90	6. 0	150	10. 0	210	14. 0	270	18. 0	330	22. 0
31	2. 4	91	6. 4	151	10. 4	211	14. 4	271	18. 4	331	22. 4
32	2. 8	92	6. 8	152	10. 8	212	14. 8	272	18. 8	332	22. 8
33	2.12	93	6.12	153	10.12	213	14.12	273	18.12	333	22.12
34	2.16	94	6.16	154	10.16	214	14.16	274	18.16	334	22.16
35	2.20	95	6.20	155	10.20	215	14.20	275	18.20	335	22.20
36	2.24	96	6.24	156	10.24	216	14.24	276	18.24	336	22.24
37	2.28	97	6.28	157	10.28	217	14.28	277	18.28	337	22.28
38	2.32	98	6.32	158	10.32	218	14.32	278	18.32	338	22.32
39	2.36	99	6.36	159	10.36	219	14.36	279	18.36	339	22.36
40	2.40	100	6.40	160	10.40	220	14.40	280	18.40	340	22.40
41	2.44	101	6.44	161	10.44	221	14.44	281	18.44	341	22.44
42	2.48	102	6.48	162	10.48	222	14.48	282	18.48	342	22.48
43	2.52	103	6.52	163	10.52	223	14.52	283	18.52	343	22.52
44	2.56	104	6.56	164	10.56	224	14.56	284	18.56	344	22.56
45	3. 0	105	7. 0	165	11. 0	225	15. 0	285	19. 0	345	23. 0
46	3. 4	106	7. 4	166	11. 4	226	15. 4	286	19. 4	346	23. 4
47	3. 8	107	7. 8	167	11. 8	227	15. 8	287	19. 8	347	23. 8
48	3.12	108	7.12	168	11.12	228	15.12	288	19.12	348	23.12
49	3.16	109	7.16	169	11.16	229	15.16	289	19.16	349	23.16
50	3.20	110	7.20	170	11.20	230	15.20	290	19.20	350	23.20
51	3.24	111	7.24	171	11.24	231	15.24	291	19.24	351	23.24
52	3.28	112	7.28	172	11.28	232	15.28	292	19.28	352	23.28
53	3.32	113	7.32	173	11.32	233	15.32	293	19.32	353	23.32
54	3.36	114	7.36	174	11.36	234	15.36	294	19.36	354	23.36
55	3.40	115	7.40	175	11.40	235	15.40	295	19.40	355	23.40
56	3.44	116	7.44	176	11.44	236	15.44	296	19.44	356	23.44
57	3.48	117	7.48	177	11.48	237	15.48	297	19.48	357	23.48
58	3.52	118	7.52	178	11.52	238	15.52	298	19.52	358	23.52
59	3.56	119	7.56	179	11.56	239	15.56	299	19.56	359	23.56
60	4. 0	120	8. 0	180	12. 0	240	16. 0	300	20. 0	360	24. 0

TABLE XXII

131

PROPORTIONAL LOGARITHMS.

S	h	m	h	m	h	m	h	m	h	m	h	m	h	m	S
	0°	0'00"	1°00'	2°00'	3°00'	4°00'	5°00'	6°00'	7°00'	8°00'					
0			2 2503	1 9542	1 7712	1 6332	1 5363	1 4771	1 4402	1 3922	0				
1	4 0334	2 2481	1 9506	1 7757	1 6514	1 5342	1 4759	1 4091	1 3513	1 3021	1				
2	3 7524	2 2419	1 9471	1 7734	1 6496	1 5334	1 4747	1 4081	1 3501	1 3001	2				
3	3 5563	2 2341	1 9433	1 7710	1 6470	1 5320	1 4735	1 4071	1 3495	1 2995	3				
4	3 4314	2 2272	1 9400	1 7680	1 6460	1 5306	1 4723	1 4061	1 3486	1 2986	4				
5	3 3615	2 2203	1 9365	1 7663	1 6443	1 5491	1 4711	1 4050	1 3477	1 2977	5				
6	3 2533	2 2134	1 9331	1 7639	1 6425	1 5477	1 4699	1 4030	1 3460	1 2960	6				
7	3 1554	2 2073	1 9296	1 7616	1 6407	1 5463	1 4680	1 4010	1 3440	1 2940	7				
8	3 1003	2 2009	1 9262	1 7592	1 6390	1 5449	1 4676	1 4020	1 3440	1 2940	8				
9	3 0752	2 1946	1 9229	1 7570	1 6372	1 5435	1 4664	1 4010	1 3440	1 2940	9				
10	3 0344	2 1893	1 9195	1 7547	1 6355	1 5421	1 4652	1 4000	1 3432	1 2932	10				
11	2 9920	2 1822	1 9162	1 7524	1 6338	1 5407	1 4640	1 3989	1 3423	1 2923	11				
12	2 9512	2 1751	1 9129	1 7501	1 6320	1 5393	1 4629	1 3979	1 3415	1 2915	12				
13	2 9104	2 1701	1 9096	1 7479	1 6303	1 5379	1 4617	1 3969	1 3406	1 2906	13				
14	2 8753	2 1642	1 9063	1 7456	1 6286	1 5365	1 4606	1 3959	1 3397	1 2897	14				
15	2 8455	2 1584	1 9031	1 7434	1 6269	1 5351	1 4594	1 3949	1 3384	1 2884	15				
16	2 8203	2 1526	1 8999	1 7412	1 6252	1 5337	1 4582	1 3939	1 3379	1 2879	16				
17	2 7950	2 1469	1 8967	1 7390	1 6235	1 5324	1 4571	1 3929	1 3371	1 2871	17				
18	2 7732	2 1414	1 8935	1 7368	1 6218	1 5310	1 4559	1 3919	1 3362	1 2862	18				
19	2 7517	2 1355	1 8904	1 7346	1 6201	1 5296	1 4548	1 3910	1 3354	1 2854	19				
20	2 7321	2 1303	1 8873	1 7324	1 6183	1 5283	1 4536	1 3900	1 3345	1 2845	20				
21	2 7112	2 1244	1 8842	1 7302	1 6168	1 5269	1 4525	1 3890	1 3336	1 2836	21				
22	2 6910	2 1196	1 8811	1 7281	1 6151	1 5256	1 4513	1 3880	1 3327	1 2827	22				
23	2 6717	2 1143	1 8779	1 7259	1 6135	1 5242	1 4502	1 3870	1 3319	1 2819	23				
24	2 6532	2 1091	1 8751	1 7237	1 6116	1 5229	1 4491	1 3860	1 3310	1 2810	24				
25	2 6355	2 1040	1 8721	1 7217	1 6102	1 5215	1 4480	1 3850	1 3301	1 2801	25				
26	2 6185	2 0990	1 8691	1 7196	1 6085	1 5202	1 4469	1 3840	1 3292	1 2792	26				
27	2 6021	2 0940	1 8661	1 7175	1 6069	1 5189	1 4457	1 3830	1 3283	1 2783	27				
28	2 5865	2 0890	1 8631	1 7154	1 6053	1 5175	1 4446	1 3820	1 3274	1 2774	28				
29	2 5716	2 0840	1 8601	1 7133	1 6037	1 5162	1 4435	1 3810	1 3265	1 2765	29				
30	2 5575	2 0792	1 8573	1 7112	1 6021	1 5149	1 4424	1 3800	1 3256	1 2756	30				
31	2 5421	2 0744	1 8544	1 7091	1 6005	1 5136	1 4413	1 3790	1 3247	1 2747	31				
32	2 5275	2 0696	1 8516	1 7071	1 5990	1 5123	1 4401	1 3780	1 3238	1 2738	32				
33	2 5129	2 0649	1 8487	1 7050	1 5973	1 5110	1 4390	1 3770	1 3229	1 2729	33				
34	2 5019	2 0603	1 8459	1 7030	1 5957	1 5097	1 4379	1 3761	1 3220	1 2720	34				
35	2 4901	2 0557	1 8431	1 7010	1 5941	1 5084	1 4368	1 3751	1 3211	1 2711	35				
36	2 4771	2 0512	1 8403	1 6990	1 5925	1 5071	1 4357	1 3741	1 3202	1 2702	36				
37	2 4652	2 0467	1 8375	1 6970	1 5909	1 5058	1 4346	1 3731	1 3193	1 2693	37				
38	2 4536	2 0422	1 8347	1 6950	1 5894	1 5045	1 4335	1 3721	1 3184	1 2684	38				
39	2 4424	2 0377	1 8320	1 6930	1 5879	1 5032	1 4324	1 3711	1 3175	1 2675	39				
40	2 4311	2 0333	1 8293	1 6910	1 5863	1 5019	1 4313	1 3700	1 3166	1 2666	40				
41	2 4206	2 0291	1 8265	1 6890	1 5847	1 5007	1 4303	1 3690	1 3157	1 2657	41				
42	2 4102	2 0249	1 8239	1 6871	1 5832	1 4994	1 4292	1 3680	1 3148	1 2648	42				
43	2 4000	2 0206	1 8212	1 6851	1 5816	1 4981	1 4281	1 3670	1 3139	1 2639	43				
44	2 3900	2 0164	1 8186	1 6832	1 5801	1 4969	1 4270	1 3660	1 3130	1 2630	44				
45	2 3802	2 0123	1 8159	1 6812	1 5786	1 4956	1 4260	1 3650	1 3121	1 2621	45				
46	2 3707	2 0081	1 8133	1 6793	1 5771	1 4943	1 4249	1 3640	1 3112	1 2612	46				
47	2 3613	2 0040	1 8107	1 6774	1 5755	1 4931	1 4238	1 3630	1 3103	1 2603	47				
48	2 3522	2 0000	1 8081	1 6755	1 5740	1 4918	1 4228	1 3620	1 3094	1 2594	48				
49	2 3432	1 9960	1 8055	1 6736	1 5725	1 4906	1 4217	1 3610	1 3085	1 2585	49				
50	2 3345	1 9920	1 8030	1 6717	1 5710	1 4894	1 4206	1 3600	1 3076	1 2576	50				
51	2 3259	1 9881	1 8004	1 6699	1 5695	1 4881	1 4195	1 3590	1 3067	1 2567	51				
52	2 3176	1 9842	1 7979	1 6679	1 5680	1 4869	1 4185	1 3580	1 3058	1 2558	52				
53	2 3091	1 9803	1 7954	1 6661	1 5666	1 4856	1 4175	1 3570	1 3049	1 2549	53				
54	2 3010	1 9765	1 7929	1 6642	1 5651	1 4844	1 4165	1 3560	1 3040	1 2540	54				
55	2 2931	1 9727	1 7904	1 6624	1 5636	1 4832	1 4154	1 3550	1 3031	1 2531	55				
56	2 2852	1 9690	1 7879	1 6605	1 5621	1 4820	1 4143	1 3540	1 3022	1 2522	56				
57	2 2775	1 9653	1 7855	1 6587	1 5607	1 4809	1 4133	1 3530	1 3013	1 2513	57				
58	2 2700	1 9615	1 7830	1 6568	1 5592	1 4795	1 4122	1 3520	1 3004	1 2504	58				
59	2 2626	1 9579	1 7806	1 6550	1 5578	1 4783	1 4112	1 3510	1 2995	1 2495	59				
S.	0°	0'00"	1°00'	2°00'	3°00'	4°00'	5°00'	6°00'	7°00'	8°00'	S.				

PROPORTIONAL LOGARITHMS.

S.	h	m	h	m	h	m	h	m	h	m	h	m	h	m	h	m	S.
	0°	9°	10°	11°	12°	13°	14°	15°	16°	17°							
0	1.3010	1.2369	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248	0							
1	1.3002	1.2341	1.2132	1.1755	1.1403	1.1066	1.0787	1.0507	1.0244	1							
2	1.2994	1.2338	1.2126	1.1749	1.1402	1.1081	1.0782	1.0502	1.0240	2							
3	1.2986	1.2331	1.2119	1.1743	1.1397	1.1076	1.0777	1.0498	1.0235	3							
4	1.2978	1.2324	1.2113	1.1737	1.1391	1.1071	1.0773	1.0493	1.0231	4							
5	1.2970	1.2317	1.2106	1.1731	1.1386	1.1066	1.0768	1.0489	1.0227	5							
6	1.2962	1.2310	1.2099	1.1725	1.1380	1.1061	1.0763	1.0484	1.0223	6							
7	1.2954	1.2302	1.2093	1.1719	1.1374	1.1055	1.0758	1.0480	1.0219	7							
8	1.2946	1.2295	1.2086	1.1713	1.1369	1.1050	1.0753	1.0475	1.0214	8							
9	1.2939	1.2288	1.2080	1.1707	1.1363	1.1045	1.0749	1.0471	1.0210	9							
10	1.2931	1.2281	1.2073	1.1701	1.1358	1.1040	1.0744	1.0467	1.0206	10							
11	1.2923	1.2274	1.2067	1.1695	1.1352	1.1035	1.0739	1.0462	1.0202	11							
12	1.2915	1.2267	1.2061	1.1689	1.1347	1.1030	1.0734	1.0458	1.0197	12							
13	1.2907	1.2260	1.2054	1.1683	1.1342	1.1025	1.0730	1.0453	1.0193	13							
14	1.2899	1.2253	1.2048	1.1677	1.1336	1.1020	1.0725	1.0449	1.0189	14							
15	1.2891	1.2245	1.2041	1.1671	1.1331	1.1015	1.0720	1.0444	1.0185	15							
16	1.2883	1.2238	1.2035	1.1665	1.1325	1.1009	1.0715	1.0440	1.0181	16							
17	1.2876	1.2231	1.2028	1.1660	1.1320	1.1004	1.0711	1.0435	1.0176	17							
18	1.2868	1.2224	1.2022	1.1654	1.1314	1.0999	1.0706	1.0431	1.0172	18							
19	1.2860	1.2217	1.2016	1.1648	1.1309	1.0994	1.0701	1.0426	1.0168	19							
20	1.2852	1.2210	1.2009	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164	20							
21	1.2845	1.2203	1.2003	1.1636	1.1298	1.0984	1.0692	1.0418	1.0160	21							
22	1.2837	1.2196	1.1996	1.1630	1.1292	1.0979	1.0687	1.0413	1.0156	22							
23	1.2829	1.2189	1.1990	1.1624	1.1287	1.0974	1.0682	1.0409	1.0151	23							
24	1.2821	1.2182	1.1984	1.1619	1.1282	1.0969	1.0678	1.0404	1.0147	24							
25	1.2814	1.2175	1.1977	1.1613	1.1276	1.0964	1.0673	1.0400	1.0143	25							
26	1.2806	1.2168	1.1971	1.1607	1.1271	1.0959	1.0668	1.0395	1.0139	26							
27	1.2798	1.2162	1.1965	1.1601	1.1266	1.0954	1.0663	1.0391	1.0135	27							
28	1.2791	1.2155	1.1958	1.1595	1.1260	1.0949	1.0659	1.0387	1.0131	28							
29	1.2783	1.2148	1.1952	1.1589	1.1255	1.0944	1.0654	1.0382	1.0126	29							
30	1.2775	1.2141	1.1946	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122	30							
31	1.2768	1.2134	1.1939	1.1578	1.1244	1.0934	1.0643	1.0374	1.0118	31							
32	1.2760	1.2127	1.1933	1.1572	1.1239	1.0929	1.0640	1.0369	1.0114	32							
33	1.2753	1.2120	1.1927	1.1566	1.1233	1.0924	1.0635	1.0365	1.0110	33							
34	1.2745	1.2113	1.1921	1.1561	1.1228	1.0919	1.0631	1.0360	1.0106	34							
35	1.2738	1.2107	1.1914	1.1555	1.1223	1.0914	1.0626	1.0356	1.0102	35							
36	1.2730	1.2100	1.1908	1.1549	1.1217	1.0909	1.0621	1.0352	1.0098	36							
37	1.2724	1.2093	1.1902	1.1543	1.1212	1.0904	1.0617	1.0347	1.0093	37							
38	1.2715	1.2086	1.1896	1.1538	1.1207	1.0899	1.0612	1.0343	1.0089	38							
39	1.2707	1.2079	1.1889	1.1532	1.1201	1.0894	1.0608	1.0339	1.0083	39							
40	1.2700	1.2072	1.1883	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081	40							
41	1.2692	1.2066	1.1877	1.1520	1.1191	1.0884	1.0598	1.0330	1.0077	41							
42	1.2685	1.2059	1.1871	1.1515	1.1186	1.0880	1.0594	1.0326	1.0073	42							
43	1.2678	1.2052	1.1865	1.1509	1.1180	1.0875	1.0589	1.0321	1.0069	43							
44	1.2670	1.2045	1.1859	1.1503	1.1175	1.0870	1.0583	1.0317	1.0065	44							
45	1.2663	1.2039	1.1852	1.1498	1.1170	1.0865	1.0580	1.0313	1.0061	45							
46	1.2655	1.2032	1.1846	1.1492	1.1164	1.0860	1.0575	1.0308	1.0057	46							
47	1.2648	1.2025	1.1840	1.1486	1.1159	1.0855	1.0571	1.0304	1.0053	47							
48	1.2640	1.2019	1.1834	1.1481	1.1154	1.0850	1.0566	1.0300	1.0049	48							
49	1.2633	1.2012	1.1828	1.1475	1.1149	1.0845	1.0562	1.0295	1.0044	49							
50	1.2626	1.2005	1.1822	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040	50							
51	1.2618	1.2000	1.1816	1.1464	1.1138	1.0835	1.0552	1.0287	1.0036	51							
52	1.2611	1.2002	1.1809	1.1458	1.1133	1.0831	1.0548	1.0282	1.0031	52							
53	1.2604	1.2005	1.1803	1.1452	1.1128	1.0826	1.0543	1.0278	1.0028	53							
54	1.2596	1.2008	1.1797	1.1447	1.1123	1.0821	1.0539	1.0274	1.0024	54							
55	1.2589	1.2012	1.1791	1.1441	1.1117	1.0816	1.0534	1.0270	1.0020	55							
56	1.2581	1.2015	1.1785	1.1436	1.1112	1.0811	1.0530	1.0265	1.0016	56							
57	1.2574	1.2019	1.1779	1.1430	1.1107	1.0806	1.0525	1.0261	1.0013	57							
58	1.2567	1.2022	1.1773	1.1424	1.1102	1.0801	1.0521	1.0257	1.0009	58							
59	1.2560	1.2025	1.1767	1.1419	1.1097	1.0797	1.0516	1.0252	1.0004	59							
S.	10°	9°	10°	11°	12°	13°	14°	15°	16°	17°	S.						

TABLE XXII.

133

PROPORTIONAL LOGARITHMS.

S.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S.
	0° 18'	0° 19'	0° 20'	0° 21'	0° 22'	0° 23'	0° 24'	0° 25'	0° 26'	0° 27'	0° 28'	0° 29'	
0	10000	9765	9542	9331	9128	8935	8751	8573	8403	8239	8081	7929	0
1	9996	9761	9539	9327	9125	8932	8748	8570	8400	8236	8079	7926	1
2	9992	9757	9535	9324	9122	8929	8745	8568	8397	8234	8076	7924	2
3	9988	9754	9532	9320	9119	8926	8742	8565	8395	8231	8073	7921	3
4	9984	9750	9528	9317	9116	8923	8739	8562	8392	8228	8071	7919	4
5	9980	9746	9524	9313	9112	8920	8736	8559	8389	8226	8068	7916	5
6	9976	9742	9521	9310	9109	8917	8733	8556	8386	8223	8066	7914	6
7	9973	9739	9517	9306	9106	8913	8730	8553	8384	8220	8063	7911	7
8	9968	9735	9514	9303	9102	8910	8727	8550	8381	8218	8061	7909	8
9	9964	9731	9510	9300	9099	8907	8724	8547	8378	8215	8058	7906	9
10	9960	9727	9506	9296	9096	8904	8721	8544	8375	8212	8055	7904	10
11	9956	9723	9503	9293	9092	8901	8718	8542	8372	8210	8053	7901	11
12	9952	9720	9499	9289	9089	8897	8715	8539	8370	8207	8050	7899	12
13	9948	9716	9496	9286	9086	8895	8712	8536	8367	8204	8048	7896	13
14	9944	9712	9492	9283	9083	8892	8709	8533	8364	8202	8045	7894	14
15	9940	9708	9488	9279	9079	8888	8706	8530	8361	8199	8043	7891	15
16	9936	9705	9485	9276	9076	8885	8703	8527	8359	8196	8040	7889	16
17	9932	9701	9481	9272	9073	8882	8700	8524	8356	8194	8037	7887	17
18	9928	9697	9478	9269	9070	8879	8697	8522	8353	8191	8035	7884	18
19	9924	9693	9474	9266	9066	8876	8694	8519	8350	8188	8032	7882	19
20	9920	9690	9471	9262	9063	8873	8691	8516	8348	8186	8030	7879	20
21	9916	9686	9467	9259	9060	8870	8688	8513	8345	8183	8027	7877	21
22	9912	9682	9464	9255	9057	8867	8685	8510	8342	8181	8025	7874	22
23	9908	9678	9460	9252	9053	8864	8682	8507	8339	8178	8022	7872	23
24	9905	9675	9456	9249	9050	8861	8679	8504	8337	8175	8020	7869	24
25	9901	9671	9453	9245	9047	8857	8676	8502	8334	8173	8017	7867	25
26	9897	9667	9449	9242	9044	8854	8673	8499	8331	8170	8014	7864	26
27	9893	9664	9446	9238	9041	8851	8670	8496	8328	8167	8012	7862	27
28	9889	9660	9442	9235	9037	8848	8667	8493	8326	8165	8009	7859	28
29	9885	9656	9439	9232	9034	8845	8664	8490	8323	8162	8007	7857	29
30	9881	9652	9435	9228	9031	8842	8661	8487	8320	8159	8004	7855	30
31	9877	9649	9432	9225	9028	8839	8658	8484	8318	8157	8002	7852	31
32	9873	9645	9428	9222	9024	8836	8655	8481	8315	8154	7999	7850	32
33	9869	9641	9425	9218	9021	8833	8652	8479	8312	8152	7997	7847	33
34	9865	9638	9421	9215	9018	8830	8649	8476	8309	8149	7994	7845	34
35	9861	9634	9417	9212	9015	8827	8646	8473	8307	8146	7992	7843	35
36	9858	9630	9414	9208	9012	8824	8643	8470	8304	8144	7989	7840	36
37	9854	9626	9411	9205	9008	8821	8640	8467	8301	8141	7987	7837	37
38	9850	9623	9407	9201	9005	8817	8637	8465	8298	8138	7984	7835	38
39	9846	9619	9404	9198	9002	8814	8635	8462	8296	8136	7981	7832	39
40	9842	9615	9400	9195	8999	8811	8632	8459	8293	8133	7979	7830	40
41	9838	9612	9397	9191	8996	8808	8629	8456	8290	8131	7976	7828	41
42	9834	9608	9393	9188	8992	8805	8626	8453	8286	8128	7974	7826	42
43	9830	9604	9390	9185	8989	8802	8623	8451	8285	8125	7971	7823	43
44	9827	9601	9386	9181	8986	8799	8620	8448	8282	8123	7969	7820	44
45	9823	9597	9383	9178	8983	8796	8617	8445	8279	8120	7966	7818	45
46	9819	9593	9379	9175	8980	8793	8614	8442	8277	8117	7964	7815	46
47	9815	9590	9376	9171	8977	8790	8611	8439	8274	8115	7961	7813	47
48	9811	9586	9372	9168	8973	8787	8608	8437	8271	8112	7959	7811	48
49	9807	9582	9369	9165	8970	8784	8605	8434	8269	8110	7956	7808	49
50	9803	9579	9365	9162	8967	8781	8602	8431	8266	8107	7954	7806	50
51	9800	9575	9362	9158	8964	8778	8599	8428	8263	8104	7951	7803	51
52	9796	9571	9358	9155	8961	8775	8597	8426	8261	8102	7949	7801	52
53	9792	9568	9355	9152	8958	8772	8594	8423	8258	8099	7946	7798	53
54	9788	9564	9351	9148	8954	8769	8591	8420	8255	8097	7944	7796	54
55	9784	9561	9348	9145	8951	8766	8588	8417	8253	8094	7941	7794	55
56	9780	9557	9344	9142	8948	8763	8585	8414	8250	8091	7939	7791	56
57	9777	9553	9341	9138	8945	8760	8582	8411	8247	8089	7936	7789	57
58	9773	9550	9337	9135	8942	8757	8579	8409	8244	8086	7934	7786	58
59	9769	9546	9334	9132	8939	8754	8576	8406	8242	8084	7931	7784	59
Σ.	0° 18'	0° 19'	0° 20'	0° 21'	0° 22'	0° 23'	0° 24'	0° 25'	0° 26'	0° 27'	0° 28'	0° 29'	

PROPORTIONAL LOGARITHMS.

B.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S
	0° 30'	0° 31'	0° 32'	0° 33'	0° 34'	0° 35'	0° 36'	0° 37'	0° 38'	0° 39'	0° 40'	0° 41'		
0	7782	7639	7501	7368	7238	7112	6990	6871	6755	6642	6532	6425	0	
1	7779	7637	7499	7365	7236	7110	6988	6869	6753	6640	6530	6423	1	
2	7777	7634	7497	7363	7234	7108	6986	6867	6751	6638	6529	6421	2	
3	7774	7632	7494	7361	7232	7106	6984	6865	6749	6637	6527	6420	3	
4	7772	7630	7492	7359	7229	7104	6982	6863	6747	6635	6525	6418	4	
5	7769	7627	7490	7357	7227	7102	6980	6861	6745	6633	6523	6416	5	
6	7767	7625	7488	7354	7225	7100	6978	6859	6743	6631	6521	6414	6	
7	7765	7623	7485	7352	7223	7097	6976	6857	6742	6629	6519	6413	7	
8	7762	7620	7483	7350	7221	7096	6974	6855	6740	6627	6518	6411	8	
9	7760	7618	7481	7348	7219	7093	6972	6853	6738	6625	6516	6409	9	
10	7757	7616	7479	7346	7217	7091	6970	6851	6736	6624	6514	6407	10	
11	7755	7613	7477	7344	7215	7089	6968	6849	6734	6622	6512	6406	11	
12	7753	7611	7474	7341	7212	7087	6966	6847	6732	6620	6510	6404	12	
13	7750	7609	7472	7339	7210	7085	6964	6845	6730	6618	6509	6402	13	
14	7748	7607	7470	7337	7207	7083	6962	6843	6728	6616	6507	6400	14	
15	7745	7604	7467	7335	7206	7081	6960	6841	6726	6614	6505	6398	15	
16	7743	7602	7465	7333	7204	7079	6958	6840	6725	6612	6503	6397	16	
17	7741	7600	7463	7330	7202	7077	6956	6838	6723	6611	6501	6395	17	
18	7738	7597	7461	7328	7200	7075	6954	6836	6721	6609	6500	6393	18	
19	7736	7595	7459	7326	7198	7073	6952	6834	6719	6607	6498	6391	19	
20	7734	7593	7457	7324	7196	7071	6950	6832	6717	6605	6496	6390	20	
21	7731	7590	7454	7322	7193	7069	6948	6830	6715	6603	6494	6388	21	
22	7729	7588	7452	7320	7191	7067	6946	6828	6713	6601	6492	6386	22	
23	7726	7586	7450	7317	7189	7065	6944	6826	6711	6600	6491	6384	23	
24	7724	7583	7447	7315	7187	7063	6942	6824	6709	6598	6489	6383	24	
25	7722	7581	7445	7313	7185	7061	6940	6822	6708	6596	6487	6381	25	
26	7719	7579	7443	7311	7183	7059	6938	6820	6706	6594	6485	6379	26	
27	7717	7577	7441	7309	7181	7057	6936	6818	6704	6592	6483	6377	27	
28	7714	7574	7438	7307	7179	7055	6934	6816	6702	6590	6482	6376	28	
29	7712	7572	7436	7305	7177	7053	6932	6814	6700	6589	6480	6374	29	
30	7710	7570	7434	7303	7175	7051	6930	6812	6698	6587	6478	6372	30	
31	7707	7567	7432	7301	7173	7049	6928	6810	6696	6585	6476	6371	31	
32	7705	7565	7430	7298	7170	7046	6926	6807	6694	6583	6475	6369	32	
33	7703	7563	7427	7296	7168	7044	6923	6804	6692	6581	6473	6367	33	
34	7700	7560	7425	7294	7166	7042	6921	6803	6691	6579	6471	6365	34	
35	7698	7558	7423	7291	7164	7040	6919	6800	6689	6578	6469	6364	35	
36	7696	7556	7421	7289	7162	7038	6918	6799	6687	6576	6467	6362	36	
37	7693	7554	7418	7287	7160	7036	6916	6797	6685	6574	6466	6360	37	
38	7691	7551	7416	7285	7158	7034	6914	6795	6683	6572	6464	6358	38	
39	7688	7549	7414	7283	7156	7032	6912	6793	6681	6570	6462	6357	39	
40	7686	7547	7412	7281	7154	7030	6910	6791	6679	6568	6460	6355	40	
41	7684	7544	7409	7279	7152	7028	6908	6789	6677	6567	6459	6353	41	
42	7681	7542	7407	7276	7149	7026	6906	6787	6675	6565	6457	6351	42	
43	7679	7540	7405	7274	7147	7023	6904	6785	6674	6563	6455	6350	43	
44	7677	7537	7403	7272	7145	7021	6902	6783	6672	6561	6453	6348	44	
45	7674	7535	7401	7270	7143	7020	6900	6781	6670	6559	6451	6346	45	
46	7672	7533	7399	7268	7141	7018	6898	6779	6668	6558	6450	6344	46	
47	7670	7531	7397	7266	7139	7016	6896	6777	6666	6556	6448	6343	47	
48	7667	7528	7394	7264	7137	7014	6894	6775	6664	6554	6446	6341	48	
49	7665	7526	7392	7261	7135	7012	6892	6773	6663	6552	6444	6339	49	
50	7663	7524	7390	7259	7133	7010	6890	6771	6661	6550	6443	6338	50	
51	7660	7522	7387	7257	7131	7008	6888	6769	6659	6548	6441	6336	51	
52	7658	7519	7385	7255	7129	7006	6886	6767	6657	6547	6439	6334	52	
53	7655	7517	7383	7253	7127	7004	6884	6765	6655	6545	6437	6332	53	
54	7653	7515	7381	7251	7124	7002	6882	6763	6653	6543	6435	6331	54	
55	7651	7513	7379	7249	7122	7000	6881	6762	6651	6541	6434	6329	55	
56	7648	7510	7376	7246	7120	6998	6879	6760	6650	6539	6432	6327	56	
57	7646	7508	7374	7244	7118	6996	6877	6758	6648	6538	6430	6325	57	
58	7644	7506	7372	7242	7116	6994	6875	6756	6646	6536	6428	6324	58	
59	7641	7503	7370	7240	7114	6992	6873	6754	6644	6534	6427	6322	59	
B.	0° 30'	0° 31'	0° 32'	0° 33'	0° 34'	0° 35'	0° 36'	0° 37'	0° 38'	0° 39'	0° 40'	0° 41'	B.	

TABLE XXII.

135

PROPORTIONAL LOGARITHMS.

S	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S
	0 42	0 43	0 44	0 45	0 46	0 47	0 48	0 49	0 50	0 51	0 52	0 53	
0	6320	6218	6116	6024	5925	5832	5740	5651	5563	5477	5391	5310	0
1	6319	6216	6117	6015	5924	5830	5739	5649	5562	5476	5391	5309	1
2	6317	6215	6115	6017	5922	5828	5737	5647	5561	5474	5390	5307	2
3	6315	6213	6113	6019	5920	5827	5736	5646	5559	5473	5389	5306	3
4	6313	6211	6112	6014	5919	5826	5734	5645	5557	5471	5387	5305	4
5	6312	6210	6110	6013	5917	5824	5733	5643	5556	5470	5386	5303	5
6	6310	6208	6108	6011	5916	5823	5731	5642	5554	5469	5385	5302	6
7	6308	6206	6107	6009	5914	5821	5730	5640	5553	5467	5383	5300	7
8	6306	6205	6105	6003	5913	5819	5729	5639	5551	5464	5380	5299	8
9	6305	6203	6103	6000	5911	5818	5727	5637	5549	5461	5378	5296	9
10	6303	6201	6102	6003	5909	5816	5725	5636	5547	5459	5375	5293	10
11	6301	6200	6100	6003	5908	5815	5724	5635	5547	5461	5377	5295	11
12	6300	6198	6099	6001	5906	5813	5722	5633	5546	5460	5376	5294	12
13	6298	6196	6097	6000	5905	5812	5721	5632	5544	5459	5375	5292	13
14	6296	6195	6095	5993	5903	5810	5719	5630	5543	5457	5373	5291	14
15	6294	6193	6094	5997	5902	5809	5718	5629	5541	5456	5372	5290	15
16	6293	6191	6092	5995	5900	5807	5716	5627	5540	5454	5370	5288	16
17	6291	6190	6090	5993	5898	5806	5715	5626	5538	5452	5369	5287	17
18	6289	6188	6089	5992	5897	5804	5713	5624	5537	5450	5368	5285	18
19	6288	6186	6087	5990	5895	5803	5712	5623	5536	5449	5366	5284	19
20	6286	6185	6085	5989	5894	5801	5710	5621	5534	5447	5363	5283	20
21	6284	6183	6084	5987	5892	5800	5709	5620	5533	5447	5364	5281	21
22	6282	6181	6082	5985	5891	5798	5707	5618	5531	5446	5362	5280	22
23	6281	6179	6081	5984	5889	5796	5706	5617	5530	5445	5361	5279	23
24	6279	6178	6079	5982	5888	5795	5704	5615	5528	5443	5359	5277	24
25	6277	6176	6077	5981	5886	5793	5703	5614	5527	5442	5358	5276	25
26	6276	6174	6076	5979	5884	5792	5701	5613	5526	5440	5357	5275	26
27	6274	6173	6074	5977	5883	5790	5700	5611	5524	5439	5355	5273	27
28	6272	6171	6072	5976	5881	5789	5699	5610	5523	5437	5354	5272	28
29	6271	6169	6071	5974	5880	5787	5697	5608	5521	5436	5353	5271	29
30	6269	6168	6069	5973	5878	5786	5696	5607	5520	5435	5351	5269	30
31	6267	6166	6067	5971	5877	5784	5694	5605	5518	5433	5350	5268	31
32	6265	6165	6066	5969	5875	5783	5693	5604	5517	5432	5348	5266	32
33	6264	6163	6064	5968	5874	5781	5691	5602	5516	5430	5347	5265	33
34	6262	6161	6063	5966	5872	5780	5690	5601	5514	5429	5346	5264	34
35	6260	6160	6061	5965	5870	5777	5687	5599	5511	5425	5341	5262	35
36	6259	6158	6059	5963	5869	5776	5686	5598	5511	5425	5343	5261	36
37	6257	6156	6058	5961	5867	5775	5685	5597	5510	5424	5341	5260	37
38	6255	6155	6056	5960	5866	5774	5684	5596	5509	5423	5340	5258	38
39	6254	6153	6055	5958	5864	5772	5682	5594	5507	5421	5338	5257	39
40	6252	6151	6053	5957	5863	5771	5681	5593	5506	5421	5337	5256	40
41	6250	6150	6051	5955	5861	5772	5682	5594	5507	5421	5338	5254	41
42	6248	6148	6050	5954	5860	5768	5677	5589	5503	5418	5334	5253	42
43	6247	6146	6048	5952	5858	5766	5676	5588	5501	5416	5332	5252	43
44	6245	6145	6046	5951	5856	5765	5674	5586	5500	5415	5331	5250	44
45	6243	6143	6043	5949	5855	5763	5673	5585	5499	5414	5331	5249	45
46	6242	6141	6043	5947	5853	5761	5671	5583	5497	5412	5329	5248	46
47	6240	6140	6041	5946	5851	5760	5670	5582	5496	5411	5327	5246	47
48	6238	6138	6040	5944	5850	5758	5669	5580	5494	5409	5325	5245	48
49	6237	6136	6038	5943	5849	5757	5667	5579	5493	5408	5324	5244	49
50	6235	6135	6037	5941	5847	5755	5665	5577	5491	5407	5323	5242	50
51	6233	6133	6035	5939	5846	5754	5664	5576	5490	5406	5322	5241	51
52	6232	6131	6033	5938	5844	5752	5663	5575	5489	5404	5321	5240	52
53	6230	6130	6032	5936	5843	5751	5661	5573	5487	5402	5319	5239	53
54	6228	6128	6030	5935	5841	5749	5659	5571	5485	5401	5317	5237	54
55	6226	6126	6029	5933	5839	5747	5657	5569	5483	5399	5315	5236	55
56	6225	6125	6027	5931	5838	5746	5656	5568	5482	5398	5314	5235	56
57	6223	6123	6025	5930	5836	5745	5655	5567	5481	5397	5313	5234	57
58	6221	6121	6024	5928	5835	5743	5653	5565	5479	5395	5311	5233	58
59	6220	6120	6022	5927	5833	5742	5652	5564	5478	5394	5310	5232	59
S.	10 42 0	43 0	44 0	45 0	46 0	47 0	48 0	49 0	50 0	51 0	52 0	53 0	S.

TABLE XXII

157

PROPORTIONAL LOGARITHMS.

S.	10 6	10 7	10 8	10 9	10 10	10 11	10 12	10 13	10 14	10 15	10 16	10 17	S.
0	4357	4292	4226	4164	4102	4040	3979	3919	3860	3802	3745	3688	0
1	4356	4291	4227	4163	4101	4039	3978	3919	3859	3801	3744	3687	1
2	4355	4290	4226	4162	4100	4038	3977	3918	3858	3800	3743	3686	2
3	4354	4289	4225	4161	4099	4037	3976	3917	3857	3799	3742	3685	3
4	4353	4288	4224	4160	4098	4036	3975	3916	3856	3798	3741	3684	4
5	4352	4287	4223	4159	4097	4035	3974	3915	3855	3797	3740	3683	5
6	4351	4286	4222	4158	4096	4034	3973	3914	3854	3796	3739	3682	6
7	4350	4285	4221	4157	4095	4033	3972	3913	3853	3795	3738	3681	7
8	4349	4284	4220	4156	4093	4032	3971	3912	3852	3794	3737	3680	8
9	4347	4283	4219	4155	4092	4031	3970	3911	3851	3793	3736	3679	9
10	4346	4282	4218	4154	4091	4030	3969	3910	3851	3792	3735	3678	10
11	4345	4281	4217	4153	4090	4029	3968	3909	3850	3791	3734	3677	11
12	4344	4280	4216	4152	4089	4028	3967	3908	3849	3790	3733	3676	12
13	4343	4279	4215	4151	4088	4027	3966	3907	3848	3789	3732	3675	13
14	4342	4278	4214	4150	4087	4026	3965	3906	3847	3788	3731	3674	14
15	4341	4277	4213	4149	4086	4025	3964	3905	3846	3787	3730	3673	15
16	4340	4276	4212	4147	4085	4024	3963	3904	3845	3786	3729	3672	16
17	4339	4275	4211	4146	4084	4023	3962	3903	3844	3785	3728	3671	17
18	4338	4274	4210	4145	4083	4022	3961	3902	3843	3784	3727	3670	18
19	4336	4273	4209	4144	4082	4021	3960	3901	3842	3783	3726	3669	19
20	4335	4272	4208	4143	4081	4020	3959	3900	3841	3782	3725	3668	20
21	4334	4271	4207	4142	4080	4019	3958	3899	3840	3781	3724	3667	21
22	4333	4270	4206	4141	4079	4018	3957	3898	3839	3780	3723	3666	22
23	4332	4269	4205	4140	4078	4017	3956	3897	3838	3779	3722	3665	23
24	4331	4268	4204	4139	4077	4016	3955	3896	3837	3778	3721	3664	24
25	4330	4267	4203	4138	4076	4015	3954	3895	3836	3777	3720	3663	25
26	4329	4266	4202	4137	4075	4014	3953	3894	3835	3776	3719	3662	26
27	4328	4265	4201	4136	4074	4013	3952	3893	3834	3775	3718	3661	27
28	4327	4264	4200	4135	4073	4012	3951	3892	3833	3774	3717	3660	28
29	4326	4263	4199	4134	4072	4011	3950	3891	3832	3773	3716	3659	29
30	4325	4262	4198	4133	4071	4010	3949	3890	3831	3772	3715	3658	30
31	4324	4261	4197	4132	4070	4009	3948	3889	3830	3771	3714	3657	31
32	4323	4260	4196	4131	4069	4008	3947	3888	3829	3770	3713	3656	32
33	4322	4259	4195	4130	4068	4007	3946	3887	3828	3769	3712	3655	33
34	4321	4258	4194	4129	4067	4006	3945	3886	3827	3768	3711	3654	34
35	4320	4257	4193	4128	4066	4005	3944	3885	3826	3767	3710	3653	35
36	4319	4256	4192	4127	4065	4004	3943	3884	3825	3766	3709	3652	36
37	4318	4255	4191	4126	4064	4003	3942	3883	3824	3765	3708	3651	37
38	4317	4254	4190	4125	4063	4002	3941	3882	3823	3764	3707	3650	38
39	4316	4253	4189	4124	4062	4001	3940	3881	3822	3763	3706	3649	39
40	4315	4252	4188	4123	4061	4000	3939	3880	3821	3762	3705	3648	40
41	4314	4251	4187	4122	4060	3999	3938	3879	3820	3761	3704	3647	41
42	4313	4250	4186	4121	4059	3998	3937	3878	3819	3760	3703	3646	42
43	4312	4249	4185	4120	4058	3997	3936	3877	3818	3759	3702	3645	43
44	4311	4248	4184	4119	4057	3996	3935	3876	3817	3758	3701	3644	44
45	4310	4247	4183	4118	4056	3995	3934	3875	3816	3757	3700	3643	45
46	4309	4246	4182	4117	4055	3994	3933	3874	3815	3756	3699	3642	46
47	4308	4245	4181	4116	4054	3993	3932	3873	3814	3755	3698	3641	47
48	4307	4244	4180	4115	4053	3992	3931	3872	3813	3754	3697	3640	48
49	4306	4243	4179	4114	4052	3991	3930	3871	3812	3753	3696	3639	49
50	4305	4242	4178	4113	4051	3990	3929	3870	3811	3752	3695	3638	50
51	4304	4241	4177	4112	4050	3989	3928	3869	3810	3751	3694	3637	51
52	4303	4240	4176	4111	4049	3988	3927	3868	3809	3750	3693	3636	52
53	4302	4239	4175	4110	4048	3987	3926	3867	3808	3749	3692	3635	53
54	4301	4238	4174	4109	4047	3986	3925	3866	3807	3748	3691	3634	54
55	4300	4237	4173	4108	4046	3985	3924	3865	3806	3747	3690	3633	55
56	4299	4236	4172	4107	4045	3984	3923	3864	3805	3746	3689	3632	56
57	4298	4235	4171	4106	4044	3983	3922	3863	3804	3745	3688	3631	57
58	4297	4234	4170	4105	4043	3982	3921	3862	3803	3744	3687	3630	58
59	4296	4233	4169	4104	4042	3981	3920	3861	3802	3743	3686	3629	59

PROPORTIONAL LOGARITHMS.

S.	h m 1° 18'	h m 1° 19'	h m 1° 20'	h m 1° 21'	h m 1° 22'	h m 1° 23'	h m 1° 24'	h m 1° 25'	h m 1° 26'	h m 1° 27'	h m 1° 28'	h m 1° 29'	S.
0	3632	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	0
1	3631	3576	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058	1
2	3630	3575	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057	2
3	3629	3574	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056	3
4	3628	3573	3518	3464	3411	3358	3306	3255	3204	3154	3105	3056	4
5	3627	3572	3517	3463	3410	3358	3306	3254	3204	3153	3104	3055	5
6	3626	3571	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054	6
7	3625	3570	3515	3462	3408	3356	3304	3253	3202	3152	3102	3053	7
8	3624	3569	3515	3461	3408	3355	3303	3252	3201	3151	3101	3052	8
9	3623	3568	3514	3460	3407	3354	3302	3251	3200	3150	3101	3052	9
10	3623	3567	3513	3459	3406	3353	3301	3250	3199	3149	3100	3051	10
11	3622	3566	3512	3458	3405	3352	3300	3249	3198	3148	3099	3050	11
12	3621	3565	3511	3457	3404	3351	3300	3248	3198	3148	3098	3049	12
13	3620	3565	3510	3456	3403	3351	3299	3247	3197	3147	3097	3048	13
14	3619	3564	3509	3455	3402	3350	3298	3247	3196	3146	3096	3047	14
15	3618	3563	3508	3454	3401	3349	3297	3246	3195	3145	3096	3047	15
16	3617	3562	3507	3454	3400	3348	3296	3245	3194	3144	3095	3046	16
17	3616	3561	3506	3453	3400	3347	3295	3244	3193	3143	3094	3045	17
18	3615	3560	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044	18
19	3614	3559	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043	19
20	3613	3558	3504	3450	3397	3345	3293	3242	3191	3141	3091	3043	20
21	3612	3557	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042	21
22	3611	3556	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041	22
23	3610	3555	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040	23
24	3610	3555	3500	3446	3393	3341	3289	3238	3188	3138	3088	3039	24
25	3609	3554	3499	3446	3393	3340	3288	3237	3187	3137	3087	3039	25
26	3608	3553	3498	3445	3392	3339	3288	3236	3186	3136	3087	3038	26
27	3607	3552	3497	3444	3391	3338	3287	3236	3185	3135	3086	3037	27
28	3606	3551	3497	3443	3390	3338	3286	3235	3184	3134	3085	3036	28
29	3605	3550	3496	3442	3389	3337	3285	3234	3183	3133	3084	3035	29
30	3604	3549	3495	3441	3388	3336	3284	3233	3183	3133	3083	3034	30
31	3603	3548	3494	3440	3387	3335	3283	3232	3182	3132	3082	3034	31
32	3602	3547	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033	32
33	3601	3546	3492	3438	3386	3333	3282	3231	3180	3130	3081	3032	33
34	3600	3545	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031	34
35	3599	3545	3490	3437	3384	3332	3280	3229	3178	3129	3079	3030	35
36	3598	3544	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030	36
37	3598	3543	3488	3435	3382	3330	3278	3227	3177	3127	3078	3029	37
38	3597	3542	3488	3434	3381	3329	3277	3226	3176	3126	3077	3028	38
39	3596	3541	3487	3433	3380	3328	3276	3225	3175	3125	3076	3027	39
40	3595	3540	3486	3432	3379	3327	3276	3225	3174	3124	3075	3026	40
41	3594	3539	3485	3431	3379	3326	3275	3224	3173	3124	3074	3026	41
42	3593	3538	3484	3431	3378	3325	3274	3223	3173	3123	3073	3025	42
43	3592	3537	3483	3430	3377	3325	3273	3222	3172	3122	3073	3024	43
44	3591	3536	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023	44
45	3590	3535	3481	3428	3375	3323	3271	3220	3170	3120	3071	3022	45
46	3589	3535	3480	3427	3374	3322	3270	3220	3169	3119	3070	3022	46
47	3588	3534	3480	3426	3373	3321	3270	3219	3168	3119	3069	3021	47
48	3587	3533	3479	3425	3372	3320	3269	3218	3166	3118	3069	3020	48
49	3587	3532	3478	3424	3372	3319	3268	3217	3167	3117	3068	3019	49
50	3586	3531	3477	3423	3371	3319	3267	3216	3166	3116	3067	3018	50
51	3585	3530	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018	51
52	3584	3529	3475	3422	3369	3317	3265	3214	3164	3114	3065	3017	52
53	3583	3528	3474	3421	3368	3316	3265	3214	3163	3114	3065	3016	53
54	3582	3527	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015	54
55	3581	3526	3472	3419	3366	3314	3263	3212	3162	3112	3063	3014	55
56	3580	3525	3471	3418	3365	3313	3262	3211	3161	3111	3062	3014	56
57	3579	3525	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013	57
58	3578	3524	3470	3416	3364	3312	3260	3209	3159	3110	3060	3012	58
59	3577	3523	3469	3415	3363	3311	3259	3209	3158	3109	3060	3011	59
S.	1° 18'	1° 19'	1° 20'	1° 21'	1° 22'	1° 23'	1° 24'	1° 25'	1° 26'	1° 27'	1° 28'	1° 29'	S.

TABLE XXII.

189

PROPORTIONAL LOGARITHMS.

S	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S
	1-30	1-31	1-32	1-33	1-34	1-35	1-36	1-37	1-38	1-39	1-40	1-41		
0	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030	2032	2034	0
1	2035	2037	2039	2041	2043	2045	2047	2049	2051	2053	2055	2057	2059	1
2	2060	2062	2064	2066	2068	2070	2072	2074	2076	2078	2080	2082	2084	2
3	2086	2088	2090	2092	2094	2096	2098	2100	2102	2104	2106	2108	2110	3
4	2112	2114	2116	2118	2120	2122	2124	2126	2128	2130	2132	2134	2136	4
5	2138	2140	2142	2144	2146	2148	2150	2152	2154	2156	2158	2160	2162	5
6	2164	2166	2168	2170	2172	2174	2176	2178	2180	2182	2184	2186	2188	6
7	2190	2192	2194	2196	2198	2200	2202	2204	2206	2208	2210	2212	2214	7
8	2216	2218	2220	2222	2224	2226	2228	2230	2232	2234	2236	2238	2240	8
9	2242	2244	2246	2248	2250	2252	2254	2256	2258	2260	2262	2264	2266	9
10	2268	2270	2272	2274	2276	2278	2280	2282	2284	2286	2288	2290	2292	10
11	2294	2296	2298	2300	2302	2304	2306	2308	2310	2312	2314	2316	2318	11
12	2320	2322	2324	2326	2328	2330	2332	2334	2336	2338	2340	2342	2344	12
13	2346	2348	2350	2352	2354	2356	2358	2360	2362	2364	2366	2368	2370	13
14	2372	2374	2376	2378	2380	2382	2384	2386	2388	2390	2392	2394	2396	14
15	2398	2400	2402	2404	2406	2408	2410	2412	2414	2416	2418	2420	2422	15
16	2424	2426	2428	2430	2432	2434	2436	2438	2440	2442	2444	2446	2448	16
17	2450	2452	2454	2456	2458	2460	2462	2464	2466	2468	2470	2472	2474	17
18	2476	2478	2480	2482	2484	2486	2488	2490	2492	2494	2496	2498	2500	18
19	2502	2504	2506	2508	2510	2512	2514	2516	2518	2520	2522	2524	2526	19
20	2528	2530	2532	2534	2536	2538	2540	2542	2544	2546	2548	2550	2552	20
21	2554	2556	2558	2560	2562	2564	2566	2568	2570	2572	2574	2576	2578	21
22	2580	2582	2584	2586	2588	2590	2592	2594	2596	2598	2600	2602	2604	22
23	2606	2608	2610	2612	2614	2616	2618	2620	2622	2624	2626	2628	2630	23
24	2632	2634	2636	2638	2640	2642	2644	2646	2648	2650	2652	2654	2656	24
25	2658	2660	2662	2664	2666	2668	2670	2672	2674	2676	2678	2680	2682	25
26	2684	2686	2688	2690	2692	2694	2696	2698	2700	2702	2704	2706	2708	26
27	2710	2712	2714	2716	2718	2720	2722	2724	2726	2728	2730	2732	2734	27
28	2736	2738	2740	2742	2744	2746	2748	2750	2752	2754	2756	2758	2760	28
29	2762	2764	2766	2768	2770	2772	2774	2776	2778	2780	2782	2784	2786	29
30	2788	2790	2792	2794	2796	2798	2800	2802	2804	2806	2808	2810	2812	30
31	2814	2816	2818	2820	2822	2824	2826	2828	2830	2832	2834	2836	2838	31
32	2840	2842	2844	2846	2848	2850	2852	2854	2856	2858	2860	2862	2864	32
33	2866	2868	2870	2872	2874	2876	2878	2880	2882	2884	2886	2888	2890	33
34	2892	2894	2896	2898	2900	2902	2904	2906	2908	2910	2912	2914	2916	34
35	2918	2920	2922	2924	2926	2928	2930	2932	2934	2936	2938	2940	2942	35
36	2944	2946	2948	2950	2952	2954	2956	2958	2960	2962	2964	2966	2968	36
37	2970	2972	2974	2976	2978	2980	2982	2984	2986	2988	2990	2992	2994	37
38	2996	2998	3000	3002	3004	3006	3008	3010	3012	3014	3016	3018	3020	38
39	3022	3024	3026	3028	3030	3032	3034	3036	3038	3040	3042	3044	3046	39
40	3048	3050	3052	3054	3056	3058	3060	3062	3064	3066	3068	3070	3072	40
41	3074	3076	3078	3080	3082	3084	3086	3088	3090	3092	3094	3096	3098	41
42	3100	3102	3104	3106	3108	3110	3112	3114	3116	3118	3120	3122	3124	42
43	3126	3128	3130	3132	3134	3136	3138	3140	3142	3144	3146	3148	3150	43
44	3152	3154	3156	3158	3160	3162	3164	3166	3168	3170	3172	3174	3176	44
45	3178	3180	3182	3184	3186	3188	3190	3192	3194	3196	3198	3200	3202	45
46	3204	3206	3208	3210	3212	3214	3216	3218	3220	3222	3224	3226	3228	46
47	3230	3232	3234	3236	3238	3240	3242	3244	3246	3248	3250	3252	3254	47
48	3256	3258	3260	3262	3264	3266	3268	3270	3272	3274	3276	3278	3280	48
49	3282	3284	3286	3288	3290	3292	3294	3296	3298	3300	3302	3304	3306	49
50	3308	3310	3312	3314	3316	3318	3320	3322	3324	3326	3328	3330	3332	50
51	3334	3336	3338	3340	3342	3344	3346	3348	3350	3352	3354	3356	3358	51
52	3360	3362	3364	3366	3368	3370	3372	3374	3376	3378	3380	3382	3384	52
53	3386	3388	3390	3392	3394	3396	3398	3400	3402	3404	3406	3408	3410	53
54	3412	3414	3416	3418	3420	3422	3424	3426	3428	3430	3432	3434	3436	54
55	3438	3440	3442	3444	3446	3448	3450	3452	3454	3456	3458	3460	3462	55
56	3464	3466	3468	3470	3472	3474	3476	3478	3480	3482	3484	3486	3488	56
57	3490	3492	3494	3496	3498	3500	3502	3504	3506	3508	3510	3512	3514	57
58	3516	3518	3520	3522	3524	3526	3528	3530	3532	3534	3536	3538	3540	58
59	3542	3544	3546	3548	3550	3552	3554	3556	3558	3560	3562	3564	3566	59
60	3568	3570	3572	3574	3576	3578	3580	3582	3584	3586	3588	3590	3592	60
61	3594	3596	3598	3600	3602	3604	3606	3608	3610	3612	3614	3616	3618	61
62	3620	3622	3624	3626	3628	3630	3632	3634	3636	3638	3640	3642	3644	62
63	3646	3648	3650	3652	3654	3656	3658	3660	3662	3664	3666	3668	3670	63
64	3672	3674	3676	3678	3680	3682	3684	3686	3688	3690	3692	3694	3696	64
65	3698	3700	3702	3704	3706	3708	3710	3712	3714	3716	3718	3720	3722	65
66	3724	3726	3728	3730	3732	3734	3736	3738	3740	3742	3744	3746	3748	66
67	3750	3752	3754	3756	3758	3760	3762	3764	3766	3768	3770	3772	3774	67
68	3776	3778	3780	3782	3784	3786	3788	3790	3792	3794	3796	3798	3800	68
69	3802	3804	3806	3808	3810	3812	3814	3816	3818	3820	3822	3824	3826	69
70	3828	3830	3832	3834	3836	3838	3840	3842	3844	3846	3848	3850	3852	70
71	3854	3856	3858	3860	3862	3864	3866	3868	3870	3872	3874	3876	3878	71
72	3880	3882	3884	3886	3888	3890	3892	3894	3896	3898	3900	3902	3904	72
73	3906	3908	3910	3912	3914	3916	3918	3920	3922	3924	3926	3928	3930	73
74	3932	3934	3936	3938	3940	3942	3944	3946	3948	3950	3952	3954	3956	74
75	3958	3960	3962	3964	3966	3968	3970	3972	3974	3976	3978	3980	3982	75
76	3984	3986	3988	3990	3992	3994	3996	3998	4000	4002	4004	4006	4008	76
77	4010	4012	4014	4016	4018	4020	4022	4024	4026	4028	4030	4032	4034	77
78	4036	4038	4040	4042	4044	4046	4048	4050	4052	4054	4056	4058	4060	78
79	4062	4064	4066	4068	4070	4072	4074	4076	4078	4080	4082	4084	4086	79
80	4088	4090	4092	4094	4096	4098	4100	4102	4104	4106	4108	4110	4112	80
81	4114	4116	4118	4120	4122	4124	4126	4128	4130	4132	4134	4136	4138	81
82	4140	4142	4144	4146	4148	4150	4152	4154	4156	4158	4160	4162	4164	82
83	4166	4168	4170	4172	4174	4176	4178	4180	4182	4184	4186	4188	4190	83
84	4192	4194	4196	4198	4200	4202	4204	4206	4208	4210	4212	4214	4216	84
85	4218	4220	4222	4224	4226	4228	4230	4232	4234	4236	4238	4240	4242	85
86	4244	4246	4248	4250	4252	4254	4256	4258	4260	4262	4264	4266	4268	86
87	4270	4272	4274	4276	4278	4280	4282	4284	4286	4288	4290	4292	4294	87
88	4296	4298	4300	4302	4304	4306	4308	4						

TABLE XXII

PROPORTIONAL LOGARITHMS.

S.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S.
	42	43	44	45	46	47	48	49	50	51	52	53		
0	2467	2474	2482	2491	2500	2509	2518	2528	2538	2549	2560	2572	0	
1	2466	2474	2482	2491	2500	2509	2518	2528	2538	2549	2560	2572	1	
2	2465	2474	2482	2491	2500	2509	2518	2527	2537	2547	2559	2571	2	
3	2464	2474	2482	2491	2500	2509	2518	2526	2536	2547	2559	2570	3	
4	2464	2472	2480	2489	2497	2506	2515	2524	2534	2545	2557	2568	4	
5	2463	2471	2479	2487	2496	2505	2514	2523	2533	2544	2556	2567	5	
6	2462	2470	2478	2487	2496	2505	2514	2523	2533	2544	2556	2567	6	
7	2462	2469	2478	2486	2495	2504	2514	2524	2534	2545	2557	2568	7	
8	2461	2469	2477	2485	2494	2503	2513	2523	2533	2544	2556	2567	8	
9	2460	2468	2476	2484	2493	2503	2512	2522	2533	2544	2556	2567	9	
10	2460	2467	2475	2484	2493	2503	2512	2522	2532	2543	2555	2566	10	
11	2459	2467	2475	2484	2493	2503	2511	2521	2532	2543	2555	2566	11	
12	2458	2466	2474	2483	2492	2501	2510	2520	2531	2542	2554	2565	12	
13	2458	2465	2473	2482	2491	2500	2510	2520	2530	2541	2553	2564	13	
14	2457	2465	2473	2481	2490	2499	2509	2519	2530	2540	2552	2563	14	
15	2456	2464	2472	2481	2490	2499	2508	2518	2529	2540	2551	2562	15	
16	2455	2463	2471	2480	2489	2498	2508	2518	2528	2539	2550	2561	16	
17	2455	2462	2471	2480	2489	2498	2507	2517	2528	2538	2550	2561	17	
18	2454	2462	2470	2479	2487	2497	2506	2517	2527	2538	2549	2560	18	
19	2453	2461	2469	2478	2487	2496	2506	2516	2526	2537	2548	2559	19	
20	2453	2460	2468	2477	2486	2495	2505	2515	2526	2536	2548	2559	20	
21	2452	2460	2468	2477	2486	2495	2504	2515	2525	2536	2547	2558	21	
22	2451	2459	2467	2476	2485	2494	2504	2514	2524	2535	2546	2557	22	
23	2450	2458	2466	2475	2484	2493	2503	2513	2524	2535	2546	2557	23	
24	2450	2458	2466	2474	2483	2493	2502	2513	2523	2534	2545	2556	24	
25	2449	2457	2465	2474	2483	2492	2502	2512	2522	2533	2544	2555	25	
26	2448	2456	2464	2473	2482	2491	2501	2511	2521	2532	2543	2554	26	
27	2448	2455	2464	2473	2481	2491	2500	2510	2521	2532	2543	2554	27	
28	2447	2455	2463	2472	2481	2490	2500	2510	2520	2531	2542	2553	28	
29	2446	2454	2462	2471	2480	2489	2499	2509	2519	2530	2541	2552	29	
30	2446	2453	2462	2471	2480	2489	2498	2508	2519	2530	2541	2552	30	
31	2445	2453	2461	2470	2479	2488	2498	2508	2518	2529	2540	2551	31	
32	2444	2452	2460	2469	2478	2487	2497	2507	2517	2528	2539	2550	32	
33	2443	2451	2459	2468	2477	2486	2496	2506	2517	2527	2538	2549	33	
34	2443	2451	2459	2467	2476	2485	2495	2505	2516	2526	2537	2548	34	
35	2442	2450	2458	2467	2476	2485	2495	2505	2516	2526	2537	2548	35	
36	2441	2449	2457	2466	2475	2484	2494	2504	2515	2525	2536	2547	36	
37	2441	2448	2457	2466	2474	2484	2494	2504	2515	2525	2536	2547	37	
38	2440	2448	2456	2465	2474	2483	2493	2503	2514	2524	2535	2546	38	
39	2439	2447	2455	2464	2473	2482	2492	2502	2513	2523	2534	2545	39	
40	2438	2446	2454	2463	2472	2481	2491	2501	2512	2522	2533	2544	40	
41	2438	2446	2454	2463	2472	2481	2491	2501	2511	2522	2532	2543	41	
42	2437	2445	2453	2462	2471	2480	2490	2500	2511	2521	2532	2543	42	
43	2436	2444	2452	2461	2470	2479	2489	2499	2510	2520	2531	2542	43	
44	2436	2444	2452	2461	2470	2479	2489	2499	2510	2520	2531	2542	44	
45	2435	2443	2451	2460	2469	2478	2488	2499	2509	2520	2531	2542	45	
46	2434	2442	2450	2459	2468	2477	2487	2498	2509	2519	2530	2541	46	
47	2433	2441	2449	2458	2467	2476	2486	2497	2507	2518	2529	2540	47	
48	2433	2441	2449	2458	2467	2476	2486	2497	2507	2517	2528	2539	48	
49	2432	2440	2448	2457	2466	2475	2485	2496	2506	2517	2528	2539	49	
50	2431	2439	2447	2456	2465	2474	2484	2495	2505	2516	2527	2538	50	
51	2431	2439	2447	2456	2465	2474	2484	2495	2505	2516	2527	2538	51	
52	2430	2438	2446	2455	2464	2473	2483	2494	2504	2515	2526	2537	52	
53	2429	2437	2445	2454	2463	2472	2482	2493	2503	2514	2525	2536	53	
54	2429	2437	2445	2454	2463	2472	2482	2493	2503	2514	2525	2536	54	
55	2428	2436	2444	2453	2462	2471	2481	2492	2502	2513	2524	2535	55	
56	2427	2435	2443	2452	2461	2470	2480	2491	2501	2512	2523	2534	56	
57	2426	2434	2442	2451	2460	2469	2479	2489	2499	2510	2521	2532	57	
58	2426	2434	2442	2451	2460	2469	2479	2489	2499	2510	2521	2532	58	
59	2425	2433	2441	2450	2459	2468	2478	2488	2499	2509	2520	2531	59	
60	2425	2433	2441	2450	2459	2468	2478	2488	2499	2509	2520	2531	60	

TABLE XXII.

141

PROPORTIONAL LOGARITHMS.

S.	h m 1° 54'	h m 1° 55'	h m 1° 56'	h m 1° 57'	h m 1° 58'	h m 1° 59'	h m 2° 0'	h m 2° 1'	h m 2° 2'	h m 2° 3'	h m 2° 4'	S.
0	1981	1946	1908	1871	1834	1797	1761	1725	1689	1654	1619	0
1	1983	1945	1908	1870	1833	1797	1760	1724	1689	1653	1618	1
2	1982	1944	1907	1870	1833	1796	1760	1724	1688	1652	1617	2
3	1982	1944	1906	1869	1832	1795	1759	1723	1687	1652	1617	3
4	1981	1943	1906	1868	1831	1794	1758	1722	1687	1651	1616	4
5	1981	1943	1905	1868	1831	1794	1758	1722	1686	1651	1616	5
6	1980	1942	1904	1867	1830	1794	1757	1721	1686	1650	1615	6
7	1979	1941	1904	1867	1830	1793	1757	1721	1685	1650	1614	7
8	1979	1941	1903	1866	1829	1792	1756	1720	1684	1649	1614	8
9	1978	1940	1903	1865	1828	1792	1755	1719	1684	1648	1613	9
10	1977	1939	1902	1865	1828	1791	1755	1719	1683	1648	1613	10
11	1977	1939	1901	1864	1827	1791	1754	1718	1683	1647	1612	11
12	1976	1938	1901	1863	1827	1790	1754	1718	1682	1647	1612	12
13	1975	1938	1900	1863	1826	1789	1753	1717	1681	1646	1611	13
14	1975	1937	1899	1862	1825	1789	1752	1717	1681	1645	1610	14
15	1974	1936	1899	1862	1825	1788	1752	1716	1680	1645	1610	15
16	1974	1936	1898	1861	1824	1785	1751	1715	1680	1644	1609	16
17	1973	1935	1898	1860	1823	1787	1751	1715	1679	1644	1609	17
18	1972	1934	1897	1860	1823	1786	1750	1714	1678	1643	1608	18
19	1972	1934	1896	1859	1822	1786	1749	1714	1678	1643	1607	19
20	1971	1933	1896	1859	1822	1785	1749	1713	1677	1642	1607	20
21	1970	1933	1895	1858	1821	1785	1748	1712	1677	1641	1606	21
22	1970	1932	1894	1857	1820	1784	1748	1712	1676	1641	1606	22
23	1969	1931	1894	1857	1820	1783	1747	1711	1676	1640	1605	23
24	1968	1931	1893	1856	1819	1783	1746	1711	1675	1640	1605	24
25	1968	1930	1893	1855	1819	1782	1746	1710	1674	1639	1604	25
26	1967	1929	1892	1855	1818	1781	1745	1709	1674	1638	1603	26
27	1967	1929	1891	1854	1817	1781	1745	1709	1673	1638	1603	27
28	1966	1928	1891	1854	1817	1780	1744	1708	1673	1637	1602	28
29	1965	1928	1890	1853	1816	1780	1743	1708	1672	1637	1602	29
30	1965	1927	1889	1852	1816	1779	1743	1707	1671	1636	1601	30
31	1964	1926	1889	1852	1815	1778	1742	1706	1671	1635	1600	31
32	1963	1926	1888	1851	1814	1778	1742	1706	1670	1635	1600	32
33	1963	1925	1888	1850	1814	1777	1741	1705	1670	1634	1599	33
34	1962	1924	1887	1850	1813	1777	1740	1705	1669	1634	1599	34
35	1962	1924	1886	1849	1812	1776	1740	1704	1668	1633	1598	35
36	1961	1923	1886	1849	1811	1775	1739	1703	1668	1633	1598	36
37	1960	1923	1885	1848	1811	1775	1738	1703	1667	1632	1597	37
38	1960	1922	1884	1847	1810	1774	1738	1702	1667	1631	1596	38
39	1959	1921	1884	1847	1810	1774	1737	1702	1666	1631	1596	39
40	1958	1921	1883	1846	1809	1773	1737	1701	1665	1630	1595	40
41	1958	1920	1883	1846	1809	1772	1737	1700	1665	1630	1595	41
42	1957	1919	1882	1845	1808	1772	1736	1700	1664	1629	1594	42
43	1956	1919	1881	1844	1808	1771	1735	1699	1664	1629	1593	43
44	1956	1918	1881	1844	1807	1771	1734	1699	1663	1628	1593	44
45	1955	1918	1880	1843	1806	1770	1734	1698	1663	1627	1592	45
46	1955	1917	1880	1843	1806	1769	1733	1697	1662	1627	1592	46
47	1954	1916	1879	1842	1805	1769	1733	1697	1661	1626	1591	47
48	1953	1916	1879	1841	1804	1768	1732	1696	1661	1626	1591	48
49	1953	1915	1878	1841	1804	1768	1731	1696	1660	1625	1590	49
50	1952	1914	1877	1840	1803	1767	1731	1695	1660	1624	1589	50
51	1951	1914	1876	1839	1803	1766	1730	1694	1659	1624	1589	51
52	1951	1913	1876	1839	1802	1766	1730	1694	1658	1623	1588	52
53	1950	1913	1875	1838	1802	1765	1729	1693	1658	1623	1588	53
54	1950	1912	1875	1838	1801	1765	1728	1693	1657	1622	1587	54
55	1949	1911	1874	1837	1800	1764	1728	1692	1657	1621	1587	55
56	1948	1911	1873	1836	1800	1763	1727	1691	1656	1621	1586	56
57	1948	1910	1873	1836	1799	1763	1727	1691	1655	1620	1585	57
58	1947	1909	1872	1835	1799	1762	1726	1690	1655	1620	1585	58
59	1946	1909	1871	1835	1798	1762	1725	1690	1654	1619	1584	59
S.	1° 54'	1° 55'	1° 56'	1° 57'	1° 58'	1° 59'	2° 0'	2° 1'	2° 2'	2° 3'	2° 4'	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S.
	2	3	4	5	6	7	8	9	10	11	12	13	
0	1504	1549	1613	1681	1747	1813	1879	1947	2014	2082	2149		0
1	1503	1548	1612	1680	1746	1812	1878	1946	2013	2081	2148		1
2	1502	1547	1611	1679	1745	1811	1877	1945	2012	2080	2147		2
3	1502	1547	1611	1679	1745	1811	1877	1945	2012	2080	2147		3
4	1501	1546	1610	1678	1744	1810	1876	1944	2011	2079	2146		4
5	1501	1546	1610	1678	1744	1810	1876	1944	2011	2079	2146		5
6	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		6
7	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		7
8	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		8
9	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		9
10	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		10
11	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		11
12	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		12
13	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		13
14	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		14
15	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		15
16	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		16
17	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		17
18	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		18
19	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		19
20	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		20
21	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		21
22	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		22
23	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		23
24	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		24
25	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		25
26	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		26
27	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		27
28	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		28
29	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		29
30	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		30
31	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		31
32	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		32
33	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		33
34	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		34
35	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		35
36	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		36
37	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		37
38	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		38
39	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		39
40	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		40
41	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		41
42	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		42
43	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		43
44	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		44
45	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		45
46	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		46
47	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		47
48	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		48
49	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		49
50	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		50
51	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		51
52	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		52
53	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		53
54	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		54
55	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		55
56	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		56
57	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		57
58	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		58
59	1500	1545	1609	1677	1743	1809	1875	1943	2010	2078	2145		59
S.	2° 2'	3° 2'	4° 2'	5° 2'	6° 2'	7° 2'	8° 2'	9° 2'	10° 2'	11° 2'	12° 2'	13° 2'	S.

TABLE XXII.

141

PROPORTIONAL LOGARITHMS.

S.	h m 2° 16'	h m 2° 17'	h m 2° 18'	h m 2° 19'	h m 2° 20'	h m 2° 21'	h m 2° 22'	h m 2° 23'	h m 2° 24'	h m 2° 25'	h m 2° 26'	S.
0	1217	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909	0
1	1217	1185	1153	1122	1091	1060	1029	0999	0969	0939	0909	1
2	1216	1184	1153	1122	1090	1060	1029	0998	0968	0938	0908	2
3	1216	1184	1152	1121	1090	1059	1028	0998	0968	0938	0907	3
4	1215	1183	1152	1120	1089	1058	1028	0997	0967	0937	0907	4
5	1215	1183	1151	1120	1089	1058	1027	0997	0967	0937	0907	5
6	1214	1182	1151	1119	1088	1057	1027	0996	0966	0936	0906	6
7	1214	1182	1150	1119	1088	1057	1026	0996	0966	0936	0906	7
8	1213	1181	1150	1118	1087	1056	1026	0995	0965	0935	0905	8
9	1213	1181	1149	1118	1087	1056	1025	0995	0965	0935	0905	9
10	1212	1180	1149	1117	1086	1055	1025	0994	0964	0934	0904	10
11	1211	1180	1148	1117	1086	1055	1024	0994	0964	0934	0904	11
12	1211	1179	1148	1116	1085	1054	1024	0993	0963	0933	0903	12
13	1210	1179	1147	1116	1085	1054	1023	0993	0963	0933	0903	13
14	1210	1178	1147	1115	1084	1053	1023	0992	0962	0932	0902	14
15	1209	1178	1146	1115	1084	1053	1022	0992	0962	0932	0902	15
16	1209	1177	1146	1114	1083	1052	1022	0991	0961	0931	0901	16
17	1208	1177	1145	1114	1083	1052	1021	0991	0961	0931	0901	17
18	1208	1176	1145	1113	1082	1051	1021	0990	0960	0930	0900	18
19	1207	1175	1144	1113	1082	1051	1020	0990	0960	0930	0900	19
20	1207	1175	1143	1112	1081	1050	1020	0989	0959	0929	0899	20
21	1206	1174	1143	1112	1081	1050	1019	0989	0959	0929	0899	21
22	1206	1174	1142	1111	1080	1049	1019	0988	0958	0928	0898	22
23	1205	1173	1142	1111	1080	1049	1018	0988	0958	0928	0898	23
24	1205	1173	1141	1110	1079	1048	1018	0987	0957	0927	0897	24
25	1204	1172	1141	1110	1079	1047	1017	0987	0957	0927	0897	25
26	1204	1172	1140	1109	1078	1047	1017	0986	0956	0926	0896	26
27	1203	1171	1140	1109	1078	1047	1016	0986	0956	0926	0896	27
28	1203	1171	1139	1108	1077	1046	1016	0985	0955	0925	0895	28
29	1202	1170	1139	1108	1076	1046	1015	0985	0955	0925	0895	29
30	1201	1170	1138	1107	1076	1045	1015	0984	0954	0924	0894	30
31	1201	1169	1138	1106	1075	1045	1014	0984	0954	0924	0894	31
32	1200	1169	1137	1106	1075	1044	1014	0983	0953	0923	0893	32
33	1200	1168	1137	1105	1074	1044	1013	0983	0953	0923	0893	33
34	1199	1168	1136	1105	1074	1043	1013	0982	0952	0922	0892	34
35	1199	1167	1136	1104	1073	1043	1012	0982	0952	0922	0892	35
36	1198	1167	1135	1104	1073	1042	1012	0981	0951	0921	0891	36
37	1198	1166	1135	1103	1072	1042	1011	0981	0951	0921	0891	37
38	1197	1165	1134	1103	1072	1041	1011	0980	0950	0920	0890	38
39	1197	1165	1134	1102	1071	1041	1010	0980	0950	0920	0890	39
40	1196	1164	1133	1102	1071	1040	1009	0979	0949	0919	0889	40
41	1196	1164	1132	1101	1070	1040	1009	0979	0949	0919	0889	41
42	1195	1163	1132	1101	1070	1039	1008	0978	0948	0918	0888	42
43	1195	1163	1131	1100	1069	1039	1008	0978	0948	0918	0888	43
44	1194	1162	1131	1100	1069	1038	1007	0977	0947	0917	0887	44
45	1193	1162	1130	1099	1068	1037	1007	0977	0947	0917	0887	45
46	1193	1161	1130	1099	1068	1037	1006	0976	0946	0916	0886	46
47	1192	1161	1129	1098	1067	1036	1006	0976	0946	0916	0886	47
48	1192	1160	1129	1098	1067	1036	1005	0975	0945	0915	0885	48
49	1191	1160	1128	1097	1066	1035	1005	0975	0945	0915	0885	49
50	1191	1159	1128	1097	1066	1035	1004	0974	0944	0914	0884	50
51	1190	1159	1127	1096	1065	1034	1004	0974	0944	0914	0884	51
52	1190	1158	1127	1096	1065	1034	1003	0973	0943	0913	0883	52
53	1189	1158	1126	1095	1064	1033	1003	0973	0943	0913	0883	53
54	1189	1157	1126	1095	1064	1033	1002	0972	0942	0912	0883	54
55	1188	1157	1125	1094	1063	1032	1002	0972	0942	0912	0882	55
56	1188	1156	1125	1094	1063	1032	1001	0971	0941	0911	0882	56
57	1187	1156	1124	1093	1062	1031	1001	0971	0941	0911	0881	57
58	1187	1155	1124	1092	1062	1031	1000	0970	0940	0910	0881	58
59	1186	1154	1123	1092	1061	1030	1000	0970	0940	0910	0880	59
S.	2° 16'	2° 17'	2° 18'	2° 19'	2° 20'	2° 21'	2° 22'	2° 23'	2° 24'	2° 25'	2° 26'	S.

PROPORTIONAL LOGARITHMS.

N.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	N.
	27	28	29	30	31	32	33	34	35	36	37		
0	0880	0850	0821	0792	0763	0734	0706	0678	0649	0621	0594	0	
1	0879	0850	0820	0791	0762	0734	0706	0677	0649	0621	0593	1	
2	0879	0849	0820	0791	0762	0733	0705	0677	0648	0621	0593	2	
3	0878	0849	0819	0790	0762	0733	0704	0676	0648	0620	0592	3	
4	0878	0848	0819	0790	0761	0732	0704	0676	0648	0620	0592	4	
5	0877	0848	0818	0789	0761	0732	0703	0675	0647	0619	0591	5	
6	0877	0847	0818	0789	0760	0731	0703	0675	0647	0619	0591	6	
7	0876	0847	0817	0788	0760	0731	0703	0674	0646	0618	0591	7	
8	0876	0846	0817	0788	0759	0730	0702	0674	0646	0618	0590	8	
9	0875	0846	0816	0787	0759	0730	0702	0673	0645	0617	0590	9	
10	0875	0845	0816	0787	0758	0730	0701	0674	0645	0617	0589	10	
11	0874	0845	0816	0787	0758	0729	0701	0672	0644	0616	0589	11	
12	0874	0844	0815	0786	0757	0729	0700	0672	0644	0616	0588	12	
13	0873	0844	0815	0786	0757	0728	0700	0671	0643	0615	0588	13	
14	0873	0843	0814	0785	0756	0728	0699	0671	0643	0615	0587	14	
15	0872	0843	0814	0785	0756	0727	0699	0670	0642	0614	0587	15	
16	0872	0842	0813	0784	0755	0727	0698	0670	0642	0614	0586	16	
17	0871	0842	0813	0784	0755	0726	0698	0670	0641	0614	0586	17	
18	0871	0841	0812	0783	0754	0726	0697	0669	0641	0613	0585	18	
19	0870	0841	0812	0783	0754	0725	0697	0669	0641	0613	0585	19	
20	0870	0840	0811	0782	0753	0725	0696	0668	0640	0612	0585	20	
21	0869	0840	0811	0782	0753	0724	0696	0668	0640	0612	0584	21	
22	0869	0839	0810	0781	0752	0724	0695	0667	0639	0611	0584	22	
23	0868	0839	0810	0781	0752	0723	0695	0667	0639	0611	0583	23	
24	0868	0838	0809	0780	0751	0723	0694	0666	0638	0610	0583	24	
25	0867	0838	0809	0780	0751	0722	0694	0666	0638	0610	0582	25	
26	0867	0837	0808	0779	0751	0722	0694	0665	0637	0609	0582	26	
27	0866	0837	0808	0779	0750	0721	0693	0665	0637	0609	0581	27	
28	0866	0836	0807	0778	0750	0721	0693	0664	0636	0609	0581	28	
29	0865	0836	0807	0778	0749	0721	0692	0664	0636	0608	0580	29	
30	0865	0835	0806	0777	0749	0720	0692	0663	0635	0608	0580	30	
31	0864	0835	0806	0777	0748	0720	0691	0663	0635	0607	0579	31	
32	0864	0834	0805	0776	0748	0719	0691	0662	0634	0607	0579	32	
33	0863	0834	0805	0776	0747	0719	0690	0662	0634	0606	0579	33	
34	0863	0834	0804	0775	0747	0718	0690	0662	0634	0606	0578	34	
35	0862	0833	0804	0775	0746	0718	0689	0661	0633	0605	0578	35	
36	0862	0833	0803	0774	0746	0717	0689	0661	0633	0605	0577	36	
37	0861	0832	0803	0774	0745	0717	0688	0660	0632	0604	0577	37	
38	0861	0832	0802	0774	0745	0716	0688	0660	0632	0604	0576	38	
39	0860	0831	0802	0773	0744	0716	0687	0659	0631	0603	0576	39	
40	0860	0831	0801	0773	0744	0715	0687	0659	0631	0603	0575	40	
41	0859	0830	0801	0772	0743	0715	0686	0658	0630	0602	0575	41	
42	0859	0830	0801	0772	0743	0714	0686	0658	0630	0602	0574	42	
43	0858	0829	0800	0771	0742	0714	0686	0657	0629	0602	0574	43	
44	0858	0829	0800	0771	0742	0713	0685	0657	0629	0601	0573	44	
45	0857	0828	0799	0770	0741	0713	0685	0656	0628	0601	0573	45	
46	0857	0828	0799	0770	0741	0712	0684	0656	0628	0600	0573	46	
47	0856	0827	0798	0769	0740	0712	0684	0655	0628	0600	0572	47	
48	0856	0827	0798	0769	0740	0711	0683	0655	0627	0599	0572	48	
49	0855	0826	0797	0768	0740	0711	0683	0655	0627	0599	0571	49	
50	0855	0825	0797	0768	0739	0711	0682	0654	0626	0598	0571	50	
51	0855	0825	0796	0767	0739	0710	0682	0654	0626	0598	0570	51	
52	0854	0825	0796	0767	0738	0710	0681	0653	0625	0597	0570	52	
53	0854	0824	0796	0766	0738	0709	0681	0653	0625	0597	0569	53	
54	0853	0824	0795	0766	0737	0709	0680	0652	0624	0596	0569	54	
55	0853	0823	0794	0765	0737	0708	0680	0652	0624	0596	0568	55	
56	0852	0823	0794	0765	0736	0708	0679	0651	0623	0595	0568	56	
57	0852	0822	0793	0764	0736	0707	0679	0651	0623	0595	0568	57	
58	0851	0822	0793	0764	0735	0707	0678	0650	0622	0595	0567	58	
59	0851	0821	0792	0763	0735	0706	0678	0650	0622	0594	0567	59	
N.	27	28	29	30	31	32	33	34	35	36	37	N.	

PROPORTIONAL LOGARITHMS.

S	h m 2° 44'	h m 2° 50'	h m 2° 51'	h m 2° 52'	h m 2° 53'	h m 2° 54'	h m 2° 55'	h m 2° 56'	h m 2° 57'	h m 2° 58'	h m 2° 59'	S.
0	0274	0248	0224	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0273	0247	0222	0197	0171	0146	0122	0097	0072	0048	0023	2
3	0273	0247	0221	0196	0171	0146	0121	0096	0072	0047	0023	3
4	0272	0247	0221	0196	0171	0146	0121	0096	0071	0047	0023	4
5	0272	0246	0221	0195	0170	0145	0120	0096	0071	0046	0022	5
6	0271	0246	0220	0195	0170	0145	0120	0095	0071	0046	0022	6
7	0271	0245	0220	0194	0169	0144	0119	0095	0070	0046	0021	7
8	0270	0245	0219	0194	0169	0144	0119	0094	0070	0045	0021	8
9	0270	0244	0219	0194	0169	0143	0119	0094	0069	0045	0021	9
10	0270	0244	0219	0193	0168	0143	0118	0093	0069	0044	0020	10
11	0269	0244	0218	0193	0168	0143	0118	0093	0068	0044	0020	11
12	0269	0243	0218	0192	0167	0142	0117	0093	0068	0044	0019	12
13	0268	0243	0217	0192	0167	0142	0117	0092	0068	0043	0019	13
14	0268	0242	0217	0192	0166	0141	0117	0092	0067	0043	0019	14
15	0267	0242	0216	0191	0166	0141	0116	0091	0067	0042	0018	15
16	0267	0241	0216	0191	0165	0141	0116	0091	0066	0042	0018	16
17	0267	0241	0216	0190	0165	0140	0115	0091	0066	0042	0017	17
18	0266	0241	0215	0190	0165	0140	0115	0090	0066	0041	0017	18
19	0266	0240	0215	0189	0164	0139	0114	0090	0065	0041	0017	19
20	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016	20
21	0265	0239	0214	0189	0163	0139	0114	0089	0064	0040	0016	21
22	0264	0239	0213	0188	0163	0138	0113	0089	0064	0040	0015	22
23	0264	0238	0213	0188	0163	0138	0113	0088	0064	0039	0015	23
24	0264	0238	0213	0187	0162	0137	0112	0088	0063	0039	0015	24
25	0263	0238	0212	0187	0162	0137	0112	0087	0063	0038	0014	25
26	0263	0237	0212	0187	0161	0136	0112	0087	0062	0038	0014	26
27	0262	0237	0211	0186	0161	0136	0111	0087	0062	0038	0013	27
28	0262	0236	0211	0186	0161	0136	0111	0086	0062	0037	0013	28
29	0261	0236	0211	0185	0160	0135	0110	0086	0061	0037	0012	29
30	0261	0235	0210	0185	0160	0135	0110	0085	0061	0036	0012	30
31	0261	0235	0210	0184	0159	0134	0110	0085	0060	0036	0012	31
32	0260	0235	0209	0184	0159	0134	0109	0084	0060	0036	0011	32
33	0260	0234	0209	0184	0158	0134	0109	0084	0060	0035	0011	33
34	0259	0234	0208	0183	0158	0133	0108	0084	0059	0035	0010	34
35	0259	0233	0208	0183	0158	0133	0108	0083	0059	0034	0010	35
36	0258	0233	0208	0182	0157	0132	0107	0083	0058	0034	0010	36
37	0258	0233	0207	0182	0157	0132	0107	0082	0058	0034	0009	37
38	0258	0232	0207	0181	0156	0131	0107	0082	0057	0033	0009	38
39	0257	0232	0206	0181	0156	0131	0106	0082	0057	0033	0008	39
40	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008	40
41	0256	0231	0205	0180	0155	0130	0105	0081	0056	0032	0007	41
42	0256	0230	0205	0180	0155	0130	0105	0080	0056	0031	0007	42
43	0255	0230	0205	0179	0154	0129	0105	0080	0055	0031	0007	43
44	0255	0230	0204	0179	0154	0129	0104	0080	0055	0031	0006	44
45	0255	0229	0204	0179	0153	0129	0104	0079	0055	0030	0006	45
46	0254	0229	0203	0178	0153	0128	0103	0079	0054	0030	0006	46
47	0254	0228	0203	0178	0153	0128	0103	0078	0054	0029	0005	47
48	0253	0228	0202	0177	0152	0127	0103	0078	0053	0029	0005	48
49	0253	0227	0202	0177	0152	0127	0102	0077	0053	0029	0004	49
50	0252	0227	0202	0176	0151	0126	0102	0077	0053	0028	0004	50
51	0252	0227	0201	0176	0151	0126	0101	0077	0052	0028	0004	51
52	0252	0226	0201	0176	0151	0126	0101	0076	0052	0027	0003	52
53	0251	0226	0200	0175	0150	0125	0100	0076	0051	0027	0003	53
54	0251	0225	0200	0175	0150	0125	0100	0075	0051	0027	0002	54
55	0250	0225	0200	0174	0149	0124	0100	0075	0051	0026	0002	55
56	0250	0224	0199	0174	0149	0124	0099	0075	0050	0026	0002	56
57	0250	0224	0199	0174	0148	0124	0099	0074	0050	0025	0001	57
58	0249	0224	0198	0173	0148	0123	0098	0074	0049	0025	0000	58
59	0249	0223	0198	0173	0148	0123	0098	0073	0049	0025	0000	59
S.	2° 49'	2° 50'	2° 51'	2° 52'	2° 53'	2° 54'	2° 55'	2° 56'	2° 57'	2° 58'	2° 59'	S.

.E XXIII. To find the Latitude by two Altitudes of the Sun. 147

ALP ELAPSED TIME

o HON R				
10'	20'	30'	40'	50'
13533				
33730	66121	53627	43936	
29324	23523	13409	13834	9693
202440				
00221	00222	00312	00790	
785939	57121161	712937	7663	
17401	72222	70790	60121	7397
5647019	33261	33306	39431	
35701	553061	54733	5634	52561
550491	14436	1220	17	66632
344823	13936	1386	12245	41417
530300	39027	2222	17	40346762
23221	33029	391	3331	32250
31243	30630	22867	22342	25727
32752	20931	26349	25774	25207
724055	23549	2016	2247	21952
220719	20412	12910	1211	12923
117961	17437	1701	12131	10098
21519	14741	11407	11372	13440
312399	12171	11751	11316	10939
310130	09740	09148	07900	03571
30731	11971	10796	08699	06331
3036110	027404	02104	01202	
70331	303175	02040	02201	02172
301316	0119200	20000	00000	00233
399606	09120	00	00	00237
197777	7974	09713	100	00000
0960239	5736	2434	00172	24392
494339	09063	05740	03119	0250
292716	92452	921	0901	1664
191131	90300	0000	0001	00113
009017	23001	1126	0011	0671
0831	18293	7717	741	7247
58678	00000	00024	00000	5070
083420	00107	0076	07	008335
704100	0000	00000	0000	0000
022014	26000	00162193	11986	
081570	01152	0116	00007	00767
700368	80170	7097	42977	73581
779193	70001	7050	07	001870628
770051	77863	77677	77491	77306
276935	76756	76574	76393	76212
1758567	76767	74899	73425	72147
274797	74624	74431	74279	74107
773765	73597	73427	73261	73093
7727007	72995	72840	72686	725103
771777	71816	71611	71423	71236
700181	70000	70001	70040	70130
169530	69725	69571	6941	69263
568962	68811	68606	68410	68261
668004	67916	67709	67522	67376
16718	66700	66500	66300	66109
563246	65601	65401	65200	65000
163401	64342	64204	64066	63928
160650	63519	63353	63248	63113
163843	62711	62578	62443	62313
163000	61949	61789	61659	61529
062271	61126	60944	60827	60719
261500	60306	60124	60011	59904
0607	59483	59301	59135	59028
060018	58697	58575	58454	58334
059294	57915	57806	57697	57588

MIDDLE TIME

o HON R				
10'	20'	30'	40'	50'
0 Int Neg				
02	16270	16373	63982	76476
12	94085			
13	00779	00578	11694	16269
23	24187	27663	00882	33870
33	41796	44144	46171	48190
43	54289	56061	57764	59403
53	6397	65400	66761	68117
63	71395	73035	74242	75370
73	78558	79609	80607	81550
83	84303	84201	84107	83977
93	89498	89294	89107	88945
103	94071	94788	95494	96180
113	98207	98860	99503	
114			00136	00761
124	01963	02581	03172	03740
134	06436	06006	06554	07093
144	09671	09184	09691	10197
154	11686	11142	11616	12085
164	14461	13911	14333	14796
174	17090	17513	17952	18406
184	19267	19867	20436	21073
194	21910	22509	23061	23648
204	24133	24732	25292	25853
214	26240	26838	27420	27997
224	28268	28857	29411	29953
234	30130	30497	30937	31451
244	32026	32320	32733	33121
254	33799	34030	34363	34791
264	35489	35760	36040	36313
274	37121	37387	37661	37943
284	38692	38949	39204	39467
294	40209	40456	40702	40947
304	41673	41912	42150	42386
314	43088	43320	43550	43779
324	44459	44683	44900	45127
334	45786	46003	46219	46434
344	47079	47281	47494	47702
354	48328	48527	48731	48934
364	49536	49734	49930	50126
374	50716	50910	51102	51294
384	51861	52052	52240	52426
394	52981	53165	53347	53529
404	54070	54249	54427	54604
414	55131	55306	55479	55652
424	56166	56336	56500	56674
434	57176	57343	57508	57677
444	58163	58322	58487	58646
454	59127	59285	59443	59600
464	60069	60223	60378	60532
474	60989	61146	61292	61443
484	61891	62039	62187	62334
494	62773	62919	63063	63207
504	63637	63779	63921	64062
514	64483	64622	64761	64900
524	65312	65446	65584	65720
534	66125	66258	66392	66525
544	66922	67053	67184	67314
554	67703	67832	67961	68089
564	68471	68597	68723	68849
574	69224	69348	69472	69595
584	69963	70085	70206	70328
594	70689	70809	70928	71047

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME							MIDDLE TIME						
1 HOUR							1 HOUR						
M	1	10	20	30	40	50	M	0'	10'	20'	30'	40'	50'
00	53700	53543	53463	53416	53382	53351	04	71403	71320	71236	71153	71071	70988
10	53289	53132	53052	52985	52931	52889	14	72104	72021	71937	71854	71771	71688
20	52878	52721	52641	52574	52520	52478	24	72793	72710	72626	72543	72460	72377
30	52467	52310	52230	52163	52109	52067	34	73470	73387	73303	73220	73137	73054
40	52056	51899	51819	51752	51698	51656	44	74157	74074	73990	73907	73824	73741
50	51645	51488	51408	51341	51287	51245	54	74842	74759	74675	74592	74509	74426
60	51234	51077	50997	50930	50876	50834	64	75527	75444	75360	75277	75194	75111
70	50823	50666	50586	50519	50465	50423	74	76212	76129	76045	75962	75879	75796
80	50412	50255	50175	50108	50054	50012	84	76897	76814	76730	76647	76564	76481
90	50001	49844	49764	49697	49643	49601	94	77582	77499	77415	77332	77249	77166
100	49590	49433	49353	49286	49232	49190	104	78267	78184	78100	78017	77934	77851
110	49179	49022	48942	48875	48821	48779	114	78952	78869	78785	78702	78619	78536
120	48768	48611	48531	48464	48410	48368	124	79637	79554	79470	79387	79304	79221
130	48357	48200	48120	48053	48000	47958	134	80322	80239	80155	80072	79989	79906
140	47946	47789	47709	47642	47588	47546	144	81007	80924	80840	80757	80674	80591
150	47535	47378	47298	47231	47177	47135	154	81692	81609	81525	81442	81359	81276
160	47124	46967	46887	46820	46766	46724	164	82377	82294	82210	82127	82044	81961
170	46713	46556	46476	46409	46355	46313	174	83062	82979	82895	82812	82729	82646
180	46302	46145	46065	45998	45944	45902	184	83747	83664	83580	83497	83414	83331
190	45891	45734	45654	45587	45533	45491	194	84432	84349	84265	84182	84099	84016
200	45480	45323	45243	45176	45122	45080	204	85117	85034	84950	84867	84784	84701
210	45069	44912	44832	44765	44711	44669	214	85802	85719	85635	85552	85469	85386
220	44658	44501	44421	44354	44300	44258	224	86487	86404	86320	86237	86154	86071
230	44247	44090	44010	43943	43889	43847	234	87172	87089	87005	86922	86839	86756
240	43836	43679	43599	43532	43478	43436	244	87857	87774	87690	87607	87524	87441
250	43425	43268	43188	43121	43067	43025	254	88542	88459	88375	88292	88209	88126
260	43014	42857	42777	42710	42656	42614	264	89227	89144	89060	88977	88894	88811
270	42603	42446	42366	42299	42245	42203	274	89912	89829	89745	89662	89579	89496
280	42192	42035	41955	41888	41834	41792	284	90597	90514	90430	90347	90264	90181
290	41781	41624	41544	41477	41423	41381	294	91282	91199	91115	91032	90949	90866
300	41370	41213	41133	41066	41012	40970	304	91967	91884	91800	91717	91634	91551
310	40959	40802	40722	40655	40601	40559	314	92652	92569	92485	92402	92319	92236
320	40548	40391	40311	40244	40190	40148	324	93337	93254	93170	93087	92994	92911
330	40137	39980	39900	39833	39779	39737	334	94022	93939	93855	93772	93689	93606
340	39726	39569	39489	39422	39368	39326	344	94707	94624	94540	94457	94374	94291
350	39315	39158	39078	39011	38957	38915	354	95392	95309	95225	95142	95059	94976
360	38904	38747	38667	38600	38546	38504	364	96077	95994	95910	95827	95744	95661
370	38493	38336	38256	38189	38135	38093	374	96762	96679	96595	96512	96429	96346
380	38082	37925	37845	37778	37724	37682	384	97447	97364	97280	97197	97114	97031
390	37671	37514	37434	37367	37313	37271	394	98132	98049	97965	97882	97799	97716
400	37260	37103	37023	36956	36902	36860	404	98817	98734	98650	98567	98484	98401
410	36849	36692	36612	36545	36491	36449	414	99502	99419	99335	99252	99169	99086
420	36438	36281	36201	36134	36080	36038	424	100187	100104	100020	99937	99854	99771
430	36027	35870	35790	35723	35669	35627	434	100872	100789	100705	100622	100539	100456
440	35616	35459	35379	35312	35258	35216	444	101557	101474	101390	101307	101224	101141
450	35205	35048	34968	34901	34847	34805	454	102242	102159	102075	101992	101909	101826
460	34794	34637	34557	34490	34436	34394	464	102927	102844	102760	102677	102594	102511
470	34383	34226	34146	34079	34025	33983	474	103612	103529	103445	103362	103279	103196
480	33972	33815	33735	33668	33614	33572	484	104297	104214	104130	104047	103964	103881
490	33561	33404	33324	33257	33203	33161	494	104982	104899	104815	104732	104649	104566
500	33150	32993	32913	32846	32792	32750	504	105667	105584	105500	105417	105334	105251
510	32739	32582	32502	32435	32381	32339	514	106352	106269	106185	106102	106019	105936
520	32328	32171	32091	32024	31970	31928	524	107037	106954	106870	106787	106704	106621
530	31917	31760	31680	31613	31559	31517	534	107722	107639	107555	107472	107389	107306
540	31506	31349	31269	31202	31148	31106	544	108407	108324	108240	108157	108074	107991
550	31095	30938	30858	30791	30737	30695	554	109092	109009	108925	108842	108759	108676
560	30684	30527	30447	30380	30326	30284	564	109777	109694	109610	109527	109444	109361
570	30273	30116	30036	29969	29915	29873	574	110462	110379	110295	110212	110129	110046
580	29862	29705	29625	29558	29504	29462	584	111147	111064	110980	110897	110814	110731
590	29451	29294	29214	29147	29093	29051	594	111832	111749	111665	111582	111499	111416
600	29040	28883	28803	28736	28682	28640	604	112517	112434	112350	112267	112184	112101

TABLE XXIII.

149

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME							MIDDLE TIME						
2 HOURS							2 HOURS						
	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
00	30103	29944	29784	29624	29464	29304	05	00000	00055	00109	00164	00218	00272
10	29776	29722	29668	29614	29561	29507	15	00327	00381	00435	00489	00542	00596
20	29453	29400	29346	29293	29239	29186	25	00650	00703	00757	00810	00864	00917
30	29133	29080	29027	28974	28921	28869	35	00970	01023	01076	01129	01182	01234
40	28816	28764	28711	28658	28605	28554	45	01287	01339	01392	01444	01496	01549
50	28502	28450	28398	28346	28293	28243	55	01601	01653	01705	01757	01808	01860
60	28191	28140	28089	28037	27986	27935	65	01912	01964	02014	02066	02117	02168
70	27884	27833	27782	27731	27680	27630	75	02219	02270	02321	02372	02423	02473
80	27579	27528	27478	27428	27378	27327	85	02524	02574	02625	02675	02725	02776
90	27277	27227	27177	27127	27078	27028	95	02826	02876	02926	02976	03025	03075
100	26974	26924	26874	26824	26774	26724	105	03125	03175	03224	03273	03322	03372
110	26672	26622	26572	26522	26472	26422	115	03421	03470	03519	03568	03616	03665
120	26370	26320	26270	26220	26170	26120	125	03714	03762	03811	03859	03908	03956
130	26069	26019	25969	25919	25869	25819	135	04004	04052	04100	04148	04196	04244
140	25768	25718	25668	25618	25568	25518	145	04292	04340	04387	04435	04482	04530
150	25467	25417	25367	25317	25267	25217	155	04577	04624	04671	04718	04765	04812
160	25166	25116	25066	25016	24966	24916	165	04859	04906	04953	05000	05046	05092
170	24865	24815	24765	24715	24665	24615	175	05139	05186	05233	05279	05324	05370
180	24564	24514	24464	24414	24364	24314	185	05416	05463	05510	05556	05603	05649
190	24263	24213	24163	24113	24063	24013	195	05690	05737	05783	05829	05875	05921
200	23962	23912	23862	23812	23762	23712	205	05962	06009	06055	06101	06147	06192
210	23661	23611	23561	23511	23461	23411	215	06232	06279	06325	06371	06416	06462
220	23360	23310	23260	23210	23160	23110	225	06500	06547	06593	06639	06684	06730
230	23059	23009	22959	22909	22859	22809	235	06765	06812	06858	06904	06949	06995
240	22758	22708	22658	22608	22558	22508	245	07028	07075	07121	07167	07212	07258
250	22457	22407	22357	22307	22257	22207	255	07284	07331	07377	07423	07468	07514
260	22156	22106	22056	22006	21956	21906	265	07542	07589	07635	07681	07726	07772
270	21855	21805	21755	21705	21655	21605	275	07797	07844	07890	07936	07981	08027
280	21554	21504	21454	21404	21354	21304	285	08049	08096	08142	08188	08233	08279
290	21253	21203	21153	21103	21053	21003	295	08300	08347	08393	08439	08484	08530
300	20952	20902	20852	20802	20752	20702	305	08549	08596	08642	08688	08733	08779
310	20651	20601	20551	20501	20451	20401	315	08794	08841	08887	08933	08978	09024
320	20350	20300	20250	20200	20150	20100	325	09037	09084	09130	09176	09221	09267
330	20049	20000	19950	19900	19850	19800	335	09277	09324	09370	09416	09461	09507
340	19748	19700	19650	19600	19550	19500	345	09518	09565	09611	09657	09702	09748
350	19447	19400	19350	19300	19250	19200	355	09755	09802	09848	09894	09939	09985
360	19146	19100	19050	19000	18950	18900	365	09990	10037	10083	10129	10174	10220
370	18845	18800	18750	18700	18650	18600	375	10225	10272	10318	10364	10409	10455
380	18544	18500	18450	18400	18350	18300	385	10454	10501	10547	10593	10638	10684
390	18243	18200	18150	18100	18050	18000	395	10683	10729	10775	10821	10866	10912
400	17942	17900	17850	17800	17750	17700	405	10910	10957	10993	11029	11060	11097
410	17641	17600	17550	17500	17450	17400	415	11135	11172	11209	11246	11283	11320
420	17340	17300	17250	17200	17150	17100	425	11357	11394	11431	11468	11505	11542
430	17039	17000	16950	16900	16850	16800	435	11578	11615	11652	11688	11725	11761
440	16738	16700	16650	16600	16550	16500	445	11797	11834	11870	11906	11942	11978
450	16437	16400	16350	16300	16250	16200	455	12014	12050	12086	12122	12158	12194
460	16136	16100	16050	16000	15950	15900	465	12229	12265	12301	12336	12372	12407
470	15835	15800	15750	15700	15650	15600	475	12443	12478	12513	12549	12584	12619
480	15534	15500	15450	15400	15350	15300	485	12654	12689	12724	12759	12794	12829
490	15233	15200	15150	15100	15050	15000	495	12864	12898	12933	12968	13002	13037
500	14932	14900	14850	14800	14750	14700	505	13071	13106	13140	13175	13209	13243
510	14631	14600	14550	14500	14450	14400	515	13277	13311	13345	13380	13413	13447
520	14330	14300	14250	14200	14150	14100	525	13481	13515	13549	13583	13616	13650
530	14029	14000	13950	13900	13850	13800	535	13684	13717	13751	13784	13818	13851
540	13728	13700	13650	13600	13550	13500	545	13884	13917	13951	13984	14017	14050
550	13427	13400	13350	13300	13250	13200	555	14083	14116	14149	14182	14215	14247
560	13126	13100	13050	13000	12950	12900	565	14280	14313	14345	14378	14411	14443
570	12825	12800	12750	12700	12650	12600	575	14476	14508	14540	14573	14605	14637
580	12524	12500	12450	12400	12350	12300	585	14669	14701	14733	14765	14797	14829
590	12223	12200	12150	12100	12050	12000	595	14861	14893	14925	14957	14988	15020

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME							MIDDLE TIME						
3 HOURS							3 HOURS						
M	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
00	15051	15020	14983	14957	14929	14894	05	15051	15083	15115	15146	15177	15209
10	14863	14832	14800	14769	14738	14707	15	15240	15271	15303	15334	15365	15396
20	14676	14645	14614	14583	14552	14521	25	15427	15458	15489	15520	15551	15582
30	14490	14460	14429	14398	14366	14337	35	15613	15645	15674	15705	15735	15766
40	14307	14276	14246	14215	14185	14155	45	15796	15827	15857	15888	15918	15948
50	14124	14094	14064	14034	14004	13974	55	15979	16009	16039	16069	16099	16129
60	13944	13914	13884	13854	13824	13794	65	16159	16189	16219	16249	16279	16309
70	13765	13735	13705	13676	13646	13617	75	16338	16368	16398	16427	16457	16486
80	13587	13557	13528	13499	13470	13441	85	16516	16545	16575	16604	16633	16662
90	13411	13382	13353	13324	13295	13266	95	16692	16721	16750	16779	16808	16837
100	13237	13208	13179	13150	13121	13093	105	16866	16895	16924	16953	16982	17010
110	13064	13035	13007	12978	12949	12921	115	17039	17068	17096	17125	17153	17182
120	12893	12864	12836	12808	12779	12751	125	17210	17239	17267	17295	17324	17352
130	12723	12694	12666	12638	12610	12582	135	17380	17408	17437	17465	17493	17521
140	12554	12526	12499	12471	12443	12415	145	17549	17577	17604	17632	17660	17688
150	12387	12360	12332	12305	12277	12249	155	17716	17743	17771	17798	17826	17854
160	12222	12195	12167	12140	12113	12085	165	17881	17908	17935	17963	17990	18018
170	12058	12031	12004	11977	11949	11922	175	18045	18072	18099	18126	18154	18181
180	11895	11868	11842	11815	11788	11761	185	18208	18235	18261	18288	18315	18343
190	11734	11708	11681	11654	11628	11601	195	18369	18395	18422	18449	18475	18502
200	11575	11548	11522	11495	11468	11443	205	18528	18555	18581	18608	18634	18660
210	11416	11390	11364	11338	11312	11285	215	18687	18713	18739	18765	18791	18818
220	11259	11233	11207	11181	11156	11130	225	18844	18870	18896	18922	18947	18973
230	11104	11077	11052	11027	11001	10975	235	18999	19025	19051	19076	19102	19128
240	10950	10924	10899	10873	10848	10822	245	19153	19179	19204	19230	19255	19281
250	10797	10772	10746	10721	10696	10671	255	19306	19331	19357	19382	19407	19433
260	10646	10620	10595	10570	10545	10520	265	19457	19483	19508	19533	19558	19583
270	10496	10471	10446	10421	10396	10371	275	19607	19632	19657	19682	19707	19732
280	10347	10322	10297	10273	10248	10224	285	19756	19781	19805	19830	19855	19880
290	10199	10175	10151	10126	10102	10077	295	19904	19928	19952	19977	20001	20025
300	10053	10029	10005	9981	9957	9933	305	20050	20074	20098	20122	20146	20170
310	9909	9885	9861	9837	9813	9789	315	20194	20218	20242	20266	20290	20314
320	9766	9742	9718	9694	9670	9646	325	20338	20362	20385	20409	20433	20456
330	9624	9600	9576	9552	9528	9504	335	20480	20504	20527	20551	20574	20597
340	9482	9458	9434	9410	9386	9362	345	20621	20644	20668	20691	20714	20737
350	9343	9319	9295	9271	9247	9223	355	20760	20784	20807	20830	20853	20876
360	9204	9181	9157	9133	9109	9085	365	20899	20922	20945	20967	20990	21013
370	9067	9044	9020	8996	8972	8948	375	21036	21059	21081	21104	21126	21149
380	8931	8908	8884	8860	8836	8812	385	21172	21194	21217	21239	21261	21284
390	8797	8773	8749	8725	8701	8677	395	21306	21328	21351	21373	21395	21417
400	8664	8640	8616	8592	8568	8544	405	21439	21462	21484	21506	21528	21550
410	8531	8507	8483	8459	8435	8411	415	21572	21595	21617	21639	21661	21683
420	8401	8377	8353	8329	8305	8281	425	21702	21724	21746	21767	21789	21810
430	8271	8247	8223	8199	8175	8151	435	21832	21853	21875	21896	21918	21939
440	8143	8119	8095	8071	8047	8023	445	21960	21982	22003	22024	22045	22067
450	8016	7992	7968	7944	7920	7896	455	22088	22109	22130	22151	22172	22193
460	7889	7865	7841	7817	7793	7769	465	22214	22235	22256	22276	22297	22318
470	7765	7741	7717	7693	7669	7645	475	22338	22359	22380	22400	22421	22442
480	7641	7617	7593	7569	7545	7521	485	22462	22483	22503	22524	22544	22564
490	7518	7494	7470	7446	7422	7398	495	22585	22606	22626	22646	22666	22686
500	7397	7373	7349	7325	7301	7277	505	22708	22729	22749	22769	22789	22809
510	7277	7253	7229	7205	7181	7157	515	22826	22846	22866	22886	22906	22926
520	7158	7134	7110	7086	7062	7038	525	22945	22965	22985	23004	23024	23043
530	7040	7016	6992	6968	6944	6920	535	23063	23083	23102	23121	23141	23160
540	6923	6899	6875	6851	6827	6803	545	23180	23200	23218	23237	23256	23275
550	6806	6782	6758	6734	6710	6686	555	23295	23314	23333	23352	23371	23391
560	6691	6667	6643	6619	6595	6571	565	23410	23429	23447	23466	23485	23504
570	6576	6552	6528	6504	6480	6456	575	23524	23543	23561	23580	23599	23618
580	6462	6438	6414	6390	6366	6342	585	23635	23654	23672	23691	23709	23728
590	6349	6325	6301	6277	6253	6229	595	23746	23765	23783	23801	23820	23839

TABLE XXIII.

131

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME						MIDDLE TIME						
4 HOURS						4 HOURS						
	10'	20'	30'	40'	50'	M	U	10'	20'	30'	40'	50'
547	0622	0621	0620	0619	0618	0.5	23836	23871	23892	23911	23929	23947
548	0612	0610	0609	0608	0607	1.5	2396	23983	24001	24019	24037	24055
549	0601	0559	0558	0557	0556	2.5	2407	24091	24108	24126	24144	24162
550	0550	0548	0547	0546	0545	3.5	2417	24197	24211	24221	24230	24237
551	0540	0537	0537	0536	0535	4.5	2428	24302	24316	24326	24335	24342
552	0530	0527	0527	0526	0525	5.5	2438	24407	24424	24441	24458	24476
553	0520	0517	0517	0516	0515	6.5	2449	24518	24535	24554	24571	24588
554	0510	0507	0507	0506	0505	7.5	2459	24612	24629	24646	24663	24680
555	0500	0497	0497	0496	0495	8.5	2469	24713	24730	24747	24763	24780
556	0450	0447	0447	0446	0445	9.5	2479	24811	24828	24846	24863	24879
557	0440	0437	0437	0436	0435	10.5	2489	24913	24930	24948	24965	24982
558	0430	0427	0427	0426	0425	11.5	2499	25010	25026	25043	25060	25077
559	0420	0417	0417	0416	0415	12.5	2509	25107	25123	25139	25156	25171
560	0410	0407	0407	0406	0405	13.5	2519	25192	25208	25223	25238	25253
561	0400	0397	0397	0396	0395	14.5	2529	25292	25307	25322	25337	25352
562	0350	0347	0347	0346	0345	15.5	2539	25392	25407	25422	25437	25452
563	0340	0337	0337	0336	0335	16.5	2549	25492	25507	25522	25537	25552
564	0330	0327	0327	0326	0325	17.5	2559	25592	25607	25622	25637	25652
565	0320	0317	0317	0316	0315	18.5	2569	25692	25707	25722	25737	25752
566	0310	0307	0307	0306	0305	19.5	2579	25792	25807	25822	25837	25852
567	0300	0297	0297	0296	0295	20.5	2589	25892	25907	25922	25937	25952
568	0250	0247	0247	0246	0245	21.5	2599	25992	26007	26022	26037	26052
569	0240	0237	0237	0236	0235	22.5	2609	26092	26107	26122	26137	26152
570	0230	0227	0227	0226	0225	23.5	2619	26192	26207	26222	26237	26252
571	0220	0217	0217	0216	0215	24.5	2629	26292	26307	26322	26337	26352
572	0210	0207	0207	0206	0205	25.5	2639	26392	26407	26422	26437	26452
573	0200	0197	0197	0196	0195	26.5	2649	26492	26507	26522	26537	26552
574	0150	0147	0147	0146	0145	27.5	2659	26592	26607	26622	26637	26652
575	0140	0137	0137	0136	0135	28.5	2669	26692	26707	26722	26737	26752
576	0130	0127	0127	0126	0125	29.5	2679	26792	26807	26822	26837	26852
577	0120	0117	0117	0116	0115	30.5	2689	26892	26907	26922	26937	26952
578	0110	0107	0107	0106	0105	31.5	2699	26992	27007	27022	27037	27052
579	0100	0097	0097	0096	0095	32.5	2709	27092	27107	27122	27137	27152
580	0050	0047	0047	0046	0045	33.5	2719	27192	27207	27222	27237	27252
581	0040	0037	0037	0036	0035	34.5	2729	27292	27307	27322	27337	27352
582	0030	0027	0027	0026	0025	35.5	2739	27392	27407	27422	27437	27452
583	0020	0017	0017	0016	0015	36.5	2749	27492	27507	27522	27537	27552
584	0010	0007	0007	0006	0005	37.5	2759	27592	27607	27622	27637	27652
585	0000	0000	0000	0000	0000	38.5	2769	27692	27707	27722	27737	27752
586	0000	0000	0000	0000	0000	39.5	2779	27792	27807	27822	27837	27852
587	0000	0000	0000	0000	0000	40.5	2789	27892	27907	27922	27937	27952
588	0000	0000	0000	0000	0000	41.5	2799	27992	28007	28022	28037	28052
589	0000	0000	0000	0000	0000	42.5	2809	28092	28107	28122	28137	28152
590	0000	0000	0000	0000	0000	43.5	2819	28192	28207	28222	28237	28252
591	0000	0000	0000	0000	0000	44.5	2829	28292	28307	28322	28337	28352
592	0000	0000	0000	0000	0000	45.5	2839	28392	28407	28422	28437	28452
593	0000	0000	0000	0000	0000	46.5	2849	28492	28507	28522	28537	28552
594	0000	0000	0000	0000	0000	47.5	2859	28592	28607	28622	28637	28652
595	0000	0000	0000	0000	0000	48.5	2869	28692	28707	28722	28737	28752
596	0000	0000	0000	0000	0000	49.5	2879	28792	28807	28822	28837	28852
597	0000	0000	0000	0000	0000	50.5	2889	28892	28907	28922	28937	28952
598	0000	0000	0000	0000	0000	51.5	2899	28992	29007	29022	29037	29052
599	0000	0000	0000	0000	0000	52.5	2909	29092	29107	29122	29137	29152
600	0000	0000	0000	0000	0000	53.5	2919	29192	29207	29222	29237	29252
601	0000	0000	0000	0000	0000	54.5	2929	29292	29307	29322	29337	29352
602	0000	0000	0000	0000	0000	55.5	2939	29392	29407	29422	29437	29452
603	0000	0000	0000	0000	0000	56.5	2949	29492	29507	29522	29537	29552
604	0000	0000	0000	0000	0000	57.5	2959	29592	29607	29622	29637	29652
605	0000	0000	0000	0000	0000	58.5	2969	29692	29707	29722	29737	29752
606	0000	0000	0000	0000	0000	59.5	2979	29792	29807	29822	29837	29852
607	0000	0000	0000	0000	0000	60.5	2989	29892	29907	29922	29937	29952
608	0000	0000	0000	0000	0000	61.5	2999	29992	30007	30022	30037	30052
609	0000	0000	0000	0000	0000	62.5	3009	30092	30107	30122	30137	30152
610	0000	0000	0000	0000	0000	63.5	3019	30192	30207	30222	30237	30252
611	0000	0000	0000	0000	0000	64.5	3029	30292	30307	30322	30337	30352
612	0000	0000	0000	0000	0000	65.5	3039	30392	30407	30422	30437	30452
613	0000	0000	0000	0000	0000	66.5	3049	30492	30507	30522	30537	30552
614	0000	0000	0000	0000	0000	67.5	3059	30592	30607	30622	30637	30652
615	0000	0000	0000	0000	0000	68.5	3069	30692	30707	30722	30737	30752
616	0000	0000	0000	0000	0000	69.5	3079	30792	30807	30822	30837	30852
617	0000	0000	0000	0000	0000	70.5	3089	30892	30907	30922	30937	30952
618	0000	0000	0000	0000	0000	71.5	3099	30992	31007	31022	31037	31052
619	0000	0000	0000	0000	0000	72.5	3109	31092	31107	31122	31137	31152
620	0000	0000	0000	0000	0000	73.5	3119	31192	31207	31222	31237	31252
621	0000	0000	0000	0000	0000	74.5	3129	31292	31307	31322	31337	31352
622	0000	0000	0000	0000	0000	75.5	3139	31392	31407	31422	31437	31452
623	0000	0000	0000	0000	0000	76.5	3149	31492	31507	31522	31537	31552
624	0000	0000	0000	0000	0000	77.5	3159	31592	31607	31622	31637	31652
625	0000	0000	0000	0000	0000	78.5	3169	31692	31707	31722	31737	31752
626	0000	0000	0000	0000	0000	79.5	3179	31792	31807	31822	31837	31852
627	0000	0000	000									

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME							MIDDLE TIME						
5 HOURS							5 HOURS						
M	0	10	20	30	40	50	M	0	10	20	30	40	50
00	0150601427	01489	01470	01450	01427	01404	05	28597	28608	28614	28624	28631	28639
10	01455	01447	01439	01430	01422	01414	15	28648	28658	28664	28674	28681	28689
20	01406	01398	01390	01381	01373	01365	25	28697	28708	28714	28724	28730	28738
30	01357	01349	01341	01333	01325	01317	35	28746	28754	28760	28770	28777	28786
40	01310	01302	01294	01286	01278	01271	45	28793	28801	28808	28817	28825	28832
50	01263	01255	01247	01239	01232	01224	55	28840	28848	28855	28864	28871	28879
60	01217	01209	01202	01194	01187	01179	65	28886	28894	28901	28910	28916	28924
70	01172	01164	01157	01150	01142	01135	75	28931	28939	28946	28955	28961	28968
80	01127	01119	01113	01106	01099	01091	85	28977	28985	28992	29001	29007	29013
90	01084	01077	01070	01063	01056	01049	95	29024	29032	29039	29048	29054	29060
100	01042	01035	01028	01021	01014	01007	105	29061	29069	29076	29085	29091	29098
110	01000	00993	00987	00980	00973	00966	115	29103	29111	29118	29127	29133	29140
120	00956	00950	00944	00937	00930	00923	125	29145	29153	29160	29169	29175	29182
130	00912	00906	00900	00893	00886	00879	135	29187	29195	29202	29211	29217	29224
140	00868	00862	00856	00849	00842	00835	145	29222	29230	29237	29246	29252	29259
150	00844	00838	00832	00825	00818	00811	155	29260	29268	29275	29284	29290	29297
160	00800	00794	00788	00781	00774	00767	165	29301	29309	29316	29325	29331	29338
170	00756	00750	00744	00737	00730	00723	175	29343	29351	29358	29367	29373	29380
180	00713	00707	00701	00694	00687	00680	185	29380	29388	29395	29404	29410	29417
190	00669	00663	00657	00650	00643	00636	195	29423	29431	29438	29447	29453	29460
200	00626	00620	00614	00607	00600	00593	205	29461	29469	29476	29485	29491	29498
210	00582	00576	00570	00563	00556	00549	215	29501	29509	29516	29525	29531	29538
220	00538	00532	00526	00519	00512	00505	225	29543	29551	29558	29567	29573	29580
230	00494	00488	00482	00475	00468	00461	235	29580	29588	29595	29604	29610	29617
240	00450	00444	00438	00431	00424	00417	245	29623	29631	29638	29647	29653	29660
250	00406	00400	00394	00387	00380	00373	255	29661	29669	29676	29685	29691	29698
260	00362	00356	00350	00343	00336	00329	265	29703	29711	29718	29727	29733	29740
270	00318	00312	00306	00299	00292	00285	275	29743	29751	29758	29767	29773	29780
280	00274	00268	00262	00255	00248	00241	285	29780	29788	29795	29804	29810	29817
290	00230	00224	00218	00211	00204	00197	295	29823	29831	29838	29847	29853	29860
300	00186	00180	00174	00167	00160	00153	305	29861	29869	29876	29885	29891	29898
310	00142	00136	00130	00123	00116	00109	315	29903	29911	29918	29927	29933	29940
320	00098	00092	00086	00079	00072	00065	325	29943	29951	29958	29967	29973	29980
330	00054	00048	00042	00035	00028	00021	335	29980	29988	29995	30004	30010	30017
340	00010	00004	00000	00000	00000	00000	345	30023	30031	30038	30047	30053	30060
350	00000	00000	00000	00000	00000	00000	355	30061	30069	30076	30085	30091	30098
360	00000	00000	00000	00000	00000	00000	365	30103	30111	30118	30127	30133	30140
370	00000	00000	00000	00000	00000	00000	375	30145	30153	30160	30169	30175	30182
380	00000	00000	00000	00000	00000	00000	385	30187	30195	30202	30211	30217	30224
390	00000	00000	00000	00000	00000	00000	395	30223	30231	30238	30247	30253	30260
400	00000	00000	00000	00000	00000	00000	405	30261	30269	30276	30285	30291	30298
410	00000	00000	00000	00000	00000	00000	415	30303	30311	30318	30327	30333	30340
420	00000	00000	00000	00000	00000	00000	425	30345	30353	30360	30369	30375	30382
430	00000	00000	00000	00000	00000	00000	435	30387	30395	30402	30411	30417	30424
440	00000	00000	00000	00000	00000	00000	445	30423	30431	30438	30447	30453	30460
450	00000	00000	00000	00000	00000	00000	455	30461	30469	30476	30485	30491	30498
460	00000	00000	00000	00000	00000	00000	465	30503	30511	30518	30527	30533	30540
470	00000	00000	00000	00000	00000	00000	475	30545	30553	30560	30569	30575	30582
480	00000	00000	00000	00000	00000	00000	485	30587	30595	30602	30611	30617	30624
490	00000	00000	00000	00000	00000	00000	495	30623	30631	30638	30647	30653	30660
500	00000	00000	00000	00000	00000	00000	505	30661	30669	30676	30685	30691	30698
510	00000	00000	00000	00000	00000	00000	515	30703	30711	30718	30727	30733	30740
520	00000	00000	00000	00000	00000	00000	525	30745	30753	30760	30769	30775	30782
530	00000	00000	00000	00000	00000	00000	535	30787	30795	30802	30811	30817	30824
540	00000	00000	00000	00000	00000	00000	545	30823	30831	30838	30847	30853	30860
550	00000	00000	00000	00000	00000	00000	555	30861	30869	30876	30885	30891	30898
560	00000	00000	00000	00000	00000	00000	565	30903	30911	30918	30927	30933	30940
570	00000	00000	00000	00000	00000	00000	575	30945	30953	30960	30969	30975	30982
580	00000	00000	00000	00000	00000	00000	585	30987	30995	31002	31011	31017	31024
590	00000	00000	00000	00000	00000	00000	595	31023	31031	31038	31047	31053	31060
600	00000	00000	00000	00000	00000	00000	605	31061	31069	31076	31085	31091	31098

TABLE XXIII.

155

To find the Latitude by two Altitudes of the Sun.

LOG RISING OR VERSED SINE.

0 HOUR.

1 HOUR.

M	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
0	Inf Neg						0	3.5314333482	53721	53950	54197	54434	
1	9.97800						1	3.5467054405	55140	55375	55608	55841	
2	0.58066	11250	22846	33079	42230	50609	2	3.5607406306	56537	56767	56997	57226	
3	0.83284	19740					3	3.5745557623	57910	58137	58363	58589	
4	1.0771	27197	28224	28492	28690	28708	4	3.5881459070	59262	59486	59708	59920	
5	1.376	34041	34224	34341	34402	34410	5	3.6015260073	60539	60761	60979	61193	
6	1.634	40402	40584	40701	40762	40770	6	3.6146961680	61911	62130	62346	62559	
7	1.8677	46000	46181	46300	46361	46370	7	3.6276663287	63211	63427	63640	63852	
8	2.0847	50900	51081	51200	51261	51270	8	3.6404364894	64511	64727	64939	65149	
9	2.2873	55000	55181	55300	55361	55370	9	3.6530266501	65711	65927	66139	66349	
10	2.4754	58300	58481	58600	58661	58670	10	3.6654268108	66911	67127	67339	67549	
11	2.6491	60800	60981	61100	61161	61170	11	3.6776269715	68111	68327	68539	68749	
12	2.8087	62500	62681	62800	62861	62870	12	3.6896271322	69311	69527	69739	69949	
13	2.9548	63400	63581	63700	63761	63770	13	3.7014272929	70511	70727	70939	71149	
14	3.0887	63500	63681	63800	63861	63870	14	3.7130274536	71711	71927	72139	72349	
15	3.2100	62800	62981	63100	63161	63170	15	3.7244276143	72911	73127	73339	73549	
16	3.3187	61300	61481	61600	61661	61670	16	3.7356277750	74111	74327	74539	74749	
17	3.4148	59000	59181	59300	59361	59370	17	3.7466279357	75311	75527	75739	75949	
18	3.4983	55900	56081	56200	56261	56270	18	3.7574280964	76511	76727	76939	77149	
19	3.5694	52100	52281	52400	52461	52470	19	3.7680282571	77711	77927	78139	78349	
20	3.6283	47700	47881	48000	48061	48070	20	3.7784284178	78911	79127	79339	79549	
21	3.6754	42800	42981	43100	43161	43170	21	3.7886285785	80111	80327	80539	80749	
22	3.7111	37500	37681	37800	37861	37870	22	3.7986287392	81311	81527	81739	81949	
23	3.7358	31900	32081	32200	32261	32270	23	3.8084289000	82511	82727	82939	83149	
24	3.7497	26000	26181	26300	26361	26370	24	3.8180290607	83711	83927	84139	84349	
25	3.7629	19900	20081	20200	20261	20270	25	3.8274292214	84911	85127	85339	85549	
26	3.7754	13600	13781	13900	13961	13970	26	3.8366293821	86111	86327	86539	86749	
27	3.7872	7000	71181	72300	72361	72370	27	3.8456295428	87311	87527	87739	87949	
28	3.7983	0000	01181	02300	02361	02370	28	3.8544297035	88511	88727	88939	89149	
29	3.8087	0000	01181	02300	02361	02370	29	3.8630298642	89711	89927	90139	90349	
30	3.8184	0000	01181	02300	02361	02370	30	3.8714299249	90911	91127	91339	91549	
31	3.8274	0000	01181	02300	02361	02370	31	3.8796299856	92111	92327	92539	92749	
32	3.8358	0000	01181	02300	02361	02370	32	3.8876299463	93311	93527	93739	93949	
33	3.8437	0000	01181	02300	02361	02370	33	3.8954299070	94511	94727	94939	95149	
34	3.8511	0000	01181	02300	02361	02370	34	3.9030298677	95711	95927	96139	96349	
35	3.8580	0000	01181	02300	02361	02370	35	3.9104298284	96911	97127	97339	97549	
36	3.8644	0000	01181	02300	02361	02370	36	3.9176297891	98111	98327	98539	98749	
37	3.8703	0000	01181	02300	02361	02370	37	3.9246297498	99311	99527	99739	99949	
38	3.8757	0000	01181	02300	02361	02370	38	3.9314297105	00511	00727	00939	01149	
39	3.8806	0000	01181	02300	02361	02370	39	3.9380296712	01711	01927	02139	02349	
40	3.8850	0000	01181	02300	02361	02370	40	3.9444296319	02911	03127	03339	03549	
41	3.8899	0000	01181	02300	02361	02370	41	3.9506295926	04111	04327	04539	04749	
42	3.8943	0000	01181	02300	02361	02370	42	3.9566295533	05311	05527	05739	05949	
43	3.8982	0000	01181	02300	02361	02370	43	3.9624295140	06511	06727	06939	07149	
44	3.9016	0000	01181	02300	02361	02370	44	3.9680294747	07711	07927	08139	08349	
45	3.9045	0000	01181	02300	02361	02370	45	3.9734294354	08911	09127	09339	09549	
46	3.9069	0000	01181	02300	02361	02370	46	3.9786293961	10111	10327	10539	10749	
47	3.9088	0000	01181	02300	02361	02370	47	3.9836293568	11311	11527	11739	11949	
48	3.9102	0000	01181	02300	02361	02370	48	3.9884293175	12511	12727	12939	13149	
49	3.9111	0000	01181	02300	02361	02370	49	3.9930292782	13711	13927	14139	14349	
50	3.9116	0000	01181	02300	02361	02370	50	3.9974292389	14911	15127	15339	15549	
51	3.9117	0000	01181	02300	02361	02370	51	4.0016291996	16111	16327	16539	16749	
52	3.9114	0000	01181	02300	02361	02370	52	4.0056291603	17311	17527	17739	17949	
53	3.9107	0000	01181	02300	02361	02370	53	4.0094291210	18511	18727	18939	19149	
54	3.9096	0000	01181	02300	02361	02370	54	4.0130290817	19711	19927	20139	20349	
55	3.9080	0000	01181	02300	02361	02370	55	4.0164290424	20911	21127	21339	21549	
56	3.9059	0000	01181	02300	02361	02370	56	4.0196290031	22111	22327	22539	22749	
57	3.9034	0000	01181	02300	02361	02370	57	4.0226289638	23311	23527	23739	23949	
58	3.9004	0000	01181	02300	02361	02370	58	4.0254289245	24511	24727	24939	25149	
59	3.8970	0000	01181	02300	02361	02370	59	4.0280288852	25711	25927	26139	26349	
60	3.8931	0000	01181	02300	02361	02370	60	4.0304288459	26911	27127	27339	27549	

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

2 HOURS.

3 HOURS.

M	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
0	4.12762	12820	12938	13055	13172	13289	0	4.46671	46747	46823	46899	46975	47051
1	4.13406	13523	13640	13756	13872	13989	1	4.47127	47203	47278	47354	47430	47505
2	4.14104	14220	14336	14451	14567	14682	2	4.47580	47656	47731	47806	47881	47956
3	4.14797	14911	15026	15140	15255	15369	3	4.48031	48106	48180	48255	48330	48404
4	4.15483	15597	15710	15824	15937	16050	4	4.48479	48553	48627	48701	48776	48850
5	4.16163	16276	16389	16501	16611	16726	5	4.48924	48998	49071	49145	49219	49293
6	4.16833	16950	17062	17173	17285	17396	6	4.49366	49440	49513	49586	49660	49733
7	4.17507	17618	17729	17840	17950	18060	7	4.49806	49879	49952	50025	50098	50170
8	4.18171	18281	18391	18500	18610	18719	8	4.50243	50316	50388	50461	50533	50605
9	4.18829	18931	19047	19156	19265	19373	9	4.50677	50750	50822	50894	50966	51038
10	4.19482	19590	19693	19806	19914	20022	10	4.51109	51181	51253	51324	51396	51467
11	4.20129	20236	20344	20451	20558	20665	11	4.51539	51610	51681	51753	51824	51895
12	4.20771	20873	20984	21091	21197	21303	12	4.51966	52037	52107	52178	52249	52319
13	4.21409	21514	21620	21725	21831	21936	13	4.52390	52461	52531	52601	52672	52742
14	4.22041	22146	22250	22355	22459	22564	14	4.52812	52882	52952	53022	53092	53162
15	4.22668	22772	22876	22980	23083	23187	15	4.53231	53301	53371	53440	53510	53579
16	4.23290	23393	23496	23599	23702	23805	16	4.53648	53718	53787	53856	53925	53994
17	4.23907	24010	24112	24214	24316	24418	17	4.54063	54132	54201	54269	54338	54407
18	4.24520	24622	24723	24825	24926	25027	18	4.54475	54544	54612	54680	54749	54817
19	4.25128	25229	25330	25430	25531	25631	19	4.54885	54953	55021	55089	55157	55225
20	4.25731	25831	25931	26031	26131	26231	20	4.55293	55360	55428	55496	55563	55630
21	4.26330	26429	26529	26628	26727	26826	21	4.55698	55765	55832	55900	55967	56034
22	4.26924	27025	27121	27220	27318	27416	22	4.56101	56168	56235	56301	56368	56435
23	4.27514	27612	27710	27807	27905	28002	23	4.56501	56568	56635	56701	56767	56834
24	4.28099	28197	28294	28391	28487	28584	24	4.56900	56966	57032	57098	57164	57230
25	4.28681	28777	28873	28969	29066	29161	25	4.57296	57362	57428	57493	57559	57625
26	4.29257	29353	29449	29544	29639	29735	26	4.57690	57755	57821	57886	57951	58017
27	4.29836	29925	30020	30115	30209	30304	27	4.58082	58147	58212	58277	58342	58407
28	4.30398	30493	30587	30681	30775	30869	28	4.58471	58536	58601	58665	58730	58794
29	4.30963	31056	31150	31243	31337	31430	29	4.58859	58923	58988	59052	59116	59180
30	4.31523	31616	31709	31801	31894	31987	30	4.59244	59308	59372	59436	59500	59564
31	4.32079	32171	32264	32356	32448	32540	31	4.59627	59691	59755	59818	59882	59945
32	4.32631	32723	32815	32906	32997	33089	32	4.60008	60072	60135	60198	60261	60324
33	4.33180	33271	33362	33453	33543	33634	33	4.60388	60450	60513	60576	60639	60701
34	4.33724	33815	33905	33995	34085	34175	34	4.60765	60827	60890	60952	61015	61077
35	4.34265	34355	34444	34534	34623	34713	35	4.61139	61202	61264	61326	61388	61450
36	4.34802	34891	34980	35069	35158	35247	36	4.61512	61574	61636	61698	61760	61822
37	4.35335	35424	35512	35601	35689	35777	37	4.61883	61945	62006	62068	62129	62191
38	4.35865	35953	36041	36128	36216	36304	38	4.62252	62313	62375	62436	62497	62558
39	4.36391	36478	36565	36653	36740	36827	39	4.62619	62680	62741	62802	62863	62923
40	4.36913	37000	37087	37173	37260	37346	40	4.62984	63045	63105	63166	63226	63287
41	4.37432	37518	37604	37690	37776	37862	41	4.63347	63407	63468	63528	63588	63648
42	4.37948	38033	38119	38204	38289	38374	42	4.63703	63768	63828	63888	63948	64008
43	4.38460	38545	38629	38714	38799	38884	43	4.64068	64127	64187	64246	64306	64365
44	4.38968	39052	39137	39221	39305	39389	44	4.64425	64484	64544	64603	64662	64721
45	4.39473	39557	39641	39725	39808	39892	45	4.64780	64839	64898	64957	65016	65075
46	4.39975	40058	40142	40225	40308	40391	46	4.65134	65193	65251	65310	65369	65427
47	4.40474	40556	40639	40722	40804	40887	47	4.65486	65544	65603	65661	65719	65777
48	4.40969	41051	41133	41215	41297	41379	48	4.65836	65894	65952	66010	66068	66126
49	4.41461	41543	41624	41706	41787	41868	49	4.66184	66242	66299	66357	66415	66472
50	4.41950	42031	42112	42193	42274	42355	50	4.66530	66588	66645	66702	66760	66817
51	4.42435	42516	42597	42677	42758	42838	51	4.66875	66932	66989	67046	67103	67160
52	4.42918	42998	43078	43158	43238	43318	52	4.67217	67274	67331	67388	67445	67502
53	4.43398	43477	43557	43636	43716	43795	53	4.67558	67615	67672	67728	67785	67841
54	4.43874	43953	44032	44111	44190	44269	54	4.67897	67954	68010	68066	68123	68179
55	4.44348	44426	44505	44583	44662	44740	55	4.68235	68291	68347	68403	68459	68515
56	4.44813	44896	44974	45052	45130	45208	56	4.68571	68627	68682	68738	68794	68849
57	4.45286	45363	45441	45518	45596	45673	57	4.68905	68960	69016	69071	69127	69182
58	4.45750	45827	45905	45982	46058	46135	58	4.69237	69292	69348	69403	69458	69513
59	4.46212	46289	46365	46442	46518	46595	59	4.69568	69623	69678	69733	69788	69842



TABLE XXIII.

155

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

4 HOURS.							5 HOURS.						
	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
04	69897	69952	70006	70061	70115	70170	04	86992	87034	87075	87116	87157	87198
14	70224	70279	70333	70387	70442	70496	14	87239	87280	87321	87362	87402	87443
24	70550	70604	70658	70712	70766	70820	24	87484	87525	87566	87606	87647	87688
34	70874	70928	70982	71036	71089	71143	34	87728	87769	87809	87850	87890	87931
44	71197	71250	71304	71357	71411	71464	44	87971	88012	88052	88093	88133	88173
54	71518	71571	71624	71678	71731	71784	54	88213	88254	88294	88334	88374	88414
64	71837	71890	71943	71996	72049	72102	64	88454	88494	88534	88574	88614	88654
74	72155	72208	72260	72313	72366	72418	74	88694	88734	88774	88814	88853	88893
84	72471	72523	72576	72628	72681	72733	84	88933	88973	89012	89052	89091	89131
94	72785	72837	72889	72942	72994	73046	94	89171	89210	89250	89289	89328	89368
104	73099	73151	73203	73254	73306	73358	104	89407	89447	89486	89525	89564	89604
114	73410	73462	73514	73565	73617	73668	114	89643	89682	89721	89760	89799	89838
124	73720	73772	73823	73874	73926	73977	124	89877	89916	89955	89994	90033	90072
134	74028	74079	74131	74182	74233	74284	134	90111	90150	90189	90227	90266	90305
144	74335	74386	74437	74488	74539	74590	144	90343	90382	90421	90460	90498	90536
154	74641	74692	74743	74793	74844	74894	154	90575	90613	90652	90690	90728	90767
164	74945	74995	75046	75096	75147	75197	164	90805	90843	90882	90920	90958	90996
174	75247	75298	75348	75398	75448	75498	174	91034	91073	91111	91149	91187	91225
184	75549	75599	75649	75699	75748	75798	184	91263	91301	91339	91377	91414	91452
194	75849	75899	75949	75997	76047	76097	194	91490	91528	91566	91603	91641	91679
204	76146	76196	76245	76295	76344	76394	204	91716	91754	91792	91829	91867	91904
214	76443	76492	76542	76591	76640	76689	214	91942	91979	92017	92054	92092	92129
224	76738	76787	76836	76885	76934	76983	224	92166	92203	92241	92278	92315	92352
234	77032	77081	77130	77179	77227	77276	234	92390	92427	92464	92501	92538	92575
244	77325	77373	77422	77470	77519	77567	244	92612	92649	92686	92723	92760	92796
254	77616	77664	77713	77761	77809	77857	254	92833	92870	92907	92944	92980	93017
264	77906	77954	78002	78050	78097	78146	264	93034	93070	93107	93144	93180	93217
274	78194	78242	78290	78338	78385	78433	274	93273	93310	93346	93382	93419	93455
284	78491	78539	78587	78634	78671	78719	284	93492	93528	93564	93600	93637	93673
294	78767	78814	78861	78908	78956	79004	294	93709	93745	93781	93817	93854	93890
304	79051	79098	79145	79192	79240	79287	304	93926	93962	93998	94034	94070	94105
314	79334	79381	79428	79475	79522	79568	314	94141	94177	94213	94249	94285	94320
324	79615	79662	79709	79756	79802	79849	324	94336	94372	94407	94443	94478	94514
334	79896	79942	79989	80035	80082	80128	334	94570	94605	94641	94676	94712	94747
344	80173	80219	80265	80311	80356	80402	344	94782	94818	94853	94889	94924	94959
354	80452	80498	80543	80589	80634	80680	354	94994	95029	95065	95100	95135	95170
364	80722	80768	80813	80858	80903	80948	364	95205	95240	95275	95310	95345	95380
374	81004	81049	81094	81139	81184	81229	374	95418	95453	95488	95523	95558	95593
384	81277	81322	81367	81412	81457	81502	384	95624	95659	95694	95728	95763	95798
394	81550	81595	81640	81685	81730	81775	394	95832	95867	95902	95936	95971	96005
404	81821	81866	81911	81956	82001	82046	404	96040	96074	96109	96143	96177	96212
414	82091	82136	82181	82226	82271	82315	414	96246	96280	96315	96349	96383	96417
424	82360	82405	82449	82494	82538	82583	424	96461	96495	96529	96563	96597	96632
434	82628	82672	82716	82761	82805	82850	434	96606	96640	96674	96708	96742	96776
444	82894	82938	82982	83026	83071	83115	444	96860	96894	96928	96962	96996	97029
454	83159	83203	83247	83291	83335	83379	454	97062	97096	97130	97163	97197	97231
464	83423	83467	83510	83554	83598	83642	464	97264	97298	97331	97365	97398	97432
474	83685	83729	83773	83816	83860	83903	474	97465	97499	97532	97565	97599	97632
484	83947	83990	84034	84077	84120	84164	484	97665	97699	97732	97765	97798	97832
494	84207	84250	84293	84337	84380	84423	494	97865	97898	97931	97964	97997	98030
504	84466	84509	84552	84595	84638	84681	504	98063	98096	98129	98162	98195	98228
514	84724	84767	84810	84852	84895	84938	514	98261	98293	98326	98359	98392	98425
524	84981	85023	85066	85108	85151	85194	524	98467	98499	98532	98565	98598	98630
534	85236	85278	85321	85363	85406	85448	534	98663	98696	98728	98761	98793	98826
544	85490	85532	85575	85617	85659	85701	544	98848	98880	98913	98945	98977	99010
554	85744	85786	85828	85870	85912	85954	554	99042	99074	99107	99139	99171	99203
564	85996	86038	86079	86121	86163	86205	564	99235	99267	99300	99332	99364	99396
574	86247	86288	86330	86372	86413	86455	574	99429	99460	99492	99524	99556	99587
584	86496	86538	86579	86621	86662	86704	584	99619	99651	99683	99715	99747	99778
594	86745	86786	86828	86869	86910	86951	594	99810	99842	99873	99905	99937	99968

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

6 HOURS.							7 HOURS.						
M	0	10	20	30	40	50	M	0	10	20	30	40	50
0.5	00000	00012	00025	00039	00053	00107	0.5	09996	10021	10046	10070	10095	10117
1.5	00129	00142	00155	00169	00183	00197	1.5	10141	10166	10190	10214	10238	10262
2.5	00222	00235	00248	00262	00275	00289	2.5	10286	10310	10334	10358	10382	10406
3.5	00322	00335	00348	00362	00375	00389	3.5	10430	10454	10477	10501	10525	10549
4.5	00429	00442	00455	00469	00482	00496	4.5	10573	10597	10620	10644	10668	10691
5.5	00557	00570	00583	00597	00610	00624	5.5	10715	10739	10763	10786	10810	10833
6.5	01122	01135	01148	01162	01175	01189	6.5	10857	10881	10904	10928	10951	10975
7.5	01200	01213	01226	01240	01253	01267	7.5	10998	11022	11045	11069	11092	11115
8.5	01300	01313	01326	01340	01353	01367	8.5	11139	11162	11185	11209	11232	11255
9.5	01400	01413	01426	01440	01453	01467	9.5	11279	11302	11325	11349	11372	11395
10.5	01500	01513	01526	01540	01553	01567	10.5	11418	11441	11464	11488	11511	11535
11.5	02000	02013	02026	02040	02053	02067	11.5	11557	11580	11603	11627	11650	11673
12.5	02100	02113	02126	02140	02153	02167	12.5	11695	11718	11741	11765	11788	11811
13.5	02200	02213	02226	02240	02253	02267	13.5	11832	11855	11878	11902	11925	11948
14.5	02300	02313	02326	02340	02353	02367	14.5	11969	11992	12015	12039	12062	12085
15.5	02400	02413	02426	02440	02453	02467	15.5	12105	12128	12151	12175	12198	12221
16.5	02500	02513	02526	02540	02553	02567	16.5	12240	12263	12286	12310	12333	12356
17.5	03000	03013	03026	03040	03053	03067	17.5	12375	12398	12421	12445	12468	12491
18.5	03100	03113	03126	03140	03153	03167	18.5	12509	12532	12555	12579	12602	12625
19.5	03200	03213	03226	03240	03253	03267	19.5	12643	12666	12689	12713	12736	12759
20.5	03300	03313	03326	03340	03353	03367	20.5	12776	12799	12822	12846	12869	12892
21.5	03400	03413	03426	03440	03453	03467	21.5	12908	12931	12954	12978	13001	13024
22.5	03500	03513	03526	03540	03553	03567	22.5	13040	13063	13086	13110	13133	13156
23.5	04000	04013	04026	04040	04053	04067	23.5	13171	13194	13217	13241	13264	13287
24.5	04100	04113	04126	04140	04153	04167	24.5	13307	13330	13353	13377	13400	13423
25.5	04200	04213	04226	04240	04253	04267	25.5	13441	13464	13487	13511	13534	13557
26.5	04300	04313	04326	04340	04353	04367	26.5	13575	13598	13621	13645	13668	13691
27.5	04400	04413	04426	04440	04453	04467	27.5	13690	13713	13736	13760	13783	13806
28.5	04500	04513	04526	04540	04553	04567	28.5	13818	13841	13864	13888	13911	13934
29.5	04600	04613	04626	04640	04653	04667	29.5	13943	13966	13989	14013	14036	14059
30.5	04700	04713	04726	04740	04753	04767	30.5	14072	14095	14118	14142	14165	14188
31.5	04800	04813	04826	04840	04853	04867	31.5	14199	14222	14245	14269	14292	14315
32.5	04900	04913	04926	04940	04953	04967	32.5	14324	14347	14370	14394	14417	14440
33.5	05000	05013	05026	05040	05053	05067	33.5	14449	14472	14495	14519	14542	14565
34.5	05100	05113	05126	05140	05153	05167	34.5	14574	14597	14620	14644	14667	14690
35.5	05200	05213	05226	05240	05253	05267	35.5	14698	14721	14744	14768	14791	14814
36.5	05300	05313	05326	05340	05353	05367	36.5	14821	14844	14867	14891	14914	14937
37.5	05400	05413	05426	05440	05453	05467	37.5	14944	14967	14990	15014	15037	15060
38.5	05500	05513	05526	05540	05553	05567	38.5	15066	15089	15112	15136	15159	15182
39.5	05600	05613	05626	05640	05653	05667	39.5	15185	15208	15231	15255	15278	15301
40.5	05700	05713	05726	05740	05753	05767	40.5	15309	15332	15355	15379	15402	15425
41.5	05800	05813	05826	05840	05853	05867	41.5	15429	15452	15475	15499	15522	15545
42.5	05900	05913	05926	05940	05953	05967	42.5	15549	15572	15595	15619	15642	15665
43.5	06000	06013	06026	06040	06053	06067	43.5	15668	15691	15714	15738	15761	15784
44.5	06100	06113	06126	06140	06153	06167	44.5	15787	15810	15833	15857	15880	15903
45.5	06200	06213	06226	06240	06253	06267	45.5	15905	15928	15951	15975	15998	16021
46.5	06300	06313	06326	06340	06353	06367	46.5	16023	16046	16069	16093	16116	16139
47.5	06400	06413	06426	06440	06453	06467	47.5	16140	16163	16186	16210	16233	16256
48.5	06500	06513	06526	06540	06553	06567	48.5	16256	16279	16302	16326	16349	16372
49.5	06600	06613	06626	06640	06653	06667	49.5	16372	16395	16418	16442	16465	16488
50.5	06700	06713	06726	06740	06753	06767	50.5	16487	16510	16533	16557	16580	16603
51.5	06800	06813	06826	06840	06853	06867	51.5	16602	16625	16648	16672	16695	16718
52.5	06900	06913	06926	06940	06953	06967	52.5	16716	16739	16762	16786	16809	16832
53.5	07000	07013	07026	07040	07053	07067	53.5	16830	16853	16876	16900	16923	16946
54.5	07100	07113	07126	07140	07153	07167	54.5	16943	16966	16989	17013	17036	17059
55.5	07200	07213	07226	07240	07253	07267	55.5	17056	17079	17102	17126	17149	17172
56.5	07300	07313	07326	07340	07353	07367	56.5	17167	17190	17213	17237	17260	17283
57.5	07400	07413	07426	07440	07453	07467	57.5	17278	17301	17324	17348	17371	17394
58.5	07500	07513	07526	07540	07553	07567	58.5	17389	17412	17435	17459	17482	17505
59.5	07600	07613	07626	07640	07653	07667	59.5	17499	17522	17545	17569	17592	17615

TABLE XXIII.

157

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE

8 HOURS							9 HOURS						
	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
05	17609	17627	17646	17664	17682	17700	05	21226	21239	21252	21265	21278	21291
15	17715	17736	17755	17773	17791	17809	15	21304	21317	21330	21343	21356	21369
25	17827	17849	17868	17886	17904	17922	25	21382	21395	21408	21421	21434	21447
35	17935	17958	17977	17995	18013	18031	35	21460	21473	21486	21499	21512	21525
45	18042	18066	18085	18103	18121	18139	45	21538	21551	21564	21577	21590	21603
55	18149	18173	18192	18210	18228	18246	55	21612	21625	21638	21651	21664	21677
65	18266	18290	18309	18327	18345	18363	65	21695	21708	21721	21734	21747	21760
75	18381	18405	18424	18442	18460	18478	75	21768	21781	21794	21807	21820	21833
85	18497	18521	18540	18558	18576	18594	85	21850	21863	21876	21889	21902	21915
95	18612	18636	18655	18673	18691	18709	95	21938	21951	21964	21977	21990	22003
105	18726	18750	18769	18787	18805	18823	105	22020	22033	22046	22059	22072	22085
115	18840	18864	18883	18901	18919	18937	115	22102	22115	22128	22141	22154	22167
125	18951	18975	18994	19012	19030	19048	125	22180	22193	22206	22219	22232	22245
135	19062	19086	19105	19123	19141	19159	135	22260	22273	22286	22299	22312	22325
145	19173	19197	19216	19234	19252	19270	145	22340	22353	22366	22379	22392	22405
155	19284	19308	19327	19345	19363	19381	155	22420	22433	22446	22459	22472	22485
165	19392	19416	19435	19453	19471	19489	165	22460	22473	22486	22499	22512	22525
175	19497	19521	19540	19558	19576	19594	175	22500	22513	22526	22539	22552	22565
185	19609	19633	19652	19670	19688	19706	185	22580	22593	22606	22619	22632	22645
195	19717	19741	19760	19778	19796	19814	195	22620	22633	22646	22659	22672	22685
205	19823	19847	19866	19884	19902	19920	205	22660	22673	22686	22699	22712	22725
215	19928	19952	19971	19989	20007	20025	215	22700	22713	22726	22739	22752	22765
225	20031	20055	20074	20092	20110	20128	225	22740	22753	22766	22779	22792	22805
235	20134	20158	20177	20195	20213	20231	235	22820	22833	22846	22859	22872	22885
245	20237	20261	20280	20298	20316	20334	245	22860	22873	22886	22899	22912	22925
255	20337	20361	20380	20398	20416	20434	255	22900	22913	22926	22939	22952	22965
265	20437	20461	20480	20498	20516	20534	265	22940	22953	22966	22979	22992	23005
275	20534	20558	20577	20595	20613	20631	275	22980	23003	23026	23049	23072	23095
285	20631	20655	20674	20692	20710	20728	285	23020	23033	23046	23059	23072	23085
295	20726	20750	20769	20787	20805	20823	295	23060	23073	23086	23099	23112	23125
305	20823	20847	20866	20884	20902	20920	305	23100	23113	23126	23139	23152	23165
315	20920	20944	20963	20981	21000	21018	315	23140	23153	23166	23179	23192	23205
325	21017	21041	21060	21078	21096	21114	325	23180	23193	23206	23219	23232	23245
335	21114	21138	21157	21175	21193	21211	335	23220	23233	23246	23259	23272	23285
345	21211	21235	21254	21272	21290	21308	345	23260	23273	23286	23299	23312	23325
355	21308	21332	21351	21369	21387	21405	355	23300	23313	23326	23339	23352	23365
365	21405	21429	21448	21466	21484	21502	365	23340	23353	23366	23379	23392	23405
375	21502	21526	21545	21563	21581	21599	375	23380	23393	23406	23419	23432	23445
385	21599	21623	21642	21660	21678	21696	385	23420	23433	23446	23459	23472	23485
395	21696	21720	21739	21757	21775	21793	395	23460	23473	23486	23499	23512	23525
405	21793	21817	21836	21854	21872	21890	405	23500	23513	23526	23539	23552	23565
415	21890	21914	21933	21951	21969	21987	415	23540	23553	23566	23579	23592	23605
425	21987	22011	22030	22048	22066	22084	425	23580	23593	23606	23619	23632	23645
435	22084	22108	22127	22145	22163	22181	435	23620	23633	23646	23659	23672	23685
445	22181	22205	22224	22242	22260	22278	445	23660	23673	23686	23699	23712	23725
455	22278	22302	22321	22339	22357	22375	455	23700	23713	23726	23739	23752	23765
465	22375	22399	22418	22436	22454	22472	465	23740	23753	23766	23779	23792	23805
475	22472	22496	22515	22533	22551	22569	475	23780	23793	23806	23819	23832	23845
485	22569	22593	22612	22630	22648	22666	485	23820	23833	23846	23859	23872	23885
495	22666	22690	22709	22727	22745	22763	495	23860	23873	23886	23899	23912	23925
505	22763	22787	22806	22824	22842	22860	505	23900	23913	23926	23939	23952	23965
515	22860	22884	22903	22921	22939	22957	515	23940	23953	23966	23979	23992	24005
525	22957	22981	23000	23018	23036	23054	525	23980	23993	24006	24019	24032	24045
535	23054	23078	23097	23115	23133	23151	535	24020	24033	24046	24059	24072	24085
545	23151	23175	23194	23212	23230	23248	545	24060	24073	24086	24099	24112	24125
555	23248	23272	23291	23309	23327	23345	555	24100	24113	24126	24139	24152	24165
565	23345	23369	23388	23406	23424	23442	565	24140	24153	24166	24179	24192	24205
575	23442	23466	23485	23503	23521	23539	575	24180	24193	24206	24219	24232	24245
585	23539	23563	23582	23600	23618	23636	585	24220	24233	24246	24259	24272	24285
595	23636	23660	23679	23697	23715	23733	595	24260	24273	24286	24299	24312	24325
605	23733	23757	23776	23794	23812	23830	605	24300	24313	24326	24339	24352	24365
615	23830	23854	23873	23891	23909	23927	615	24340	24353	24366	24379	24392	24405
625	23927	23951	23970	23988	24006	24024	625	24380	24393	24406	24419	24432	24445
635	24024	24048	24067	24085	24103	24121	635	24420	24433	24446	24459	24472	24485
645	24121	24145	24164	24182	24200	24218	645	24460	24473	24486	24499	24512	24525
655	24218	24242	24261	24279	24297	24315	655	24500	24513	24526	24539	24552	24565
665	24315	24339	24358	24376	24394	24412	665	24540	24553	24566	24579	24592	24605
675	24412	24436	24455	24473	24491	24509	675	24580	24593	24606	24619	24632	24645
685	24509	24533	24552	24570	24588	24606	685	24620	24633	24646	24659	24672	24685
695	24606	24630	24649	24667	24685	24703	695	24660	24673	24686	24699	24712	24725
705	24703	24727	24746	24764	24782	24800	705	24700	24713	24726	24739	24752	24765
715	24800	24824	24843	24861	24879	24897	715	24740	24753	24766	24779	24792	24805
725	24897	24921	24940	24958	24976	24994	725	24780	24793	24806	24819	24832	24845
735	24994	25018	25037	25055	25073	25091	735	24820	24833	24846	24859	24872	24885
745	25091	25115	25134	25152	25170	25188	745	24860	24873	24886	24899	24912	24925
755	25188	25212	25231	25249	25267	25285	755	24900	24913	24926	24939	24952	24965
765	25285	25309	25328	25346	25364	25382	765	24940	24953	24966	24979	24992	25005
775	25382	25406	25425	25443	25461	25479	775	24980	24993	25006	25019	25032	25045
785	25479	25503	25522	25540	25558	25576	785	25020	25033	25046	25059	25072	25085
795	25576	25600	25619	25637	25655	25673	795	25060	25073	25086	25099	25112	25125
805	25673	25697	25716	25734	25752	25770	805	25100	25113	25126	25139	25152	25165
815	25770	25794	25813	25831	25849	25867	815	25140	25153	25166	25179	25192	25205
825	25867	25891	25910	25928	25946	25964	825	25180	25193	25206	25219	25232	25245
835	25964	25988	26007	26025	26043	26061	835	25220	25233	25246	25259	25272	25285
845	26061	26085	26104	26122	26140	26158	845	25260	25273	25286	25299	25312	25325
855													

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

10 HOURS.							11 HOURS.						
M	0'	10'	20'	30'	40'	50'	M	0'	10'	20'	30'	40'	50'
0	5.2702	27100	27109	27117	27126	27134	0	5.29357	29361	29365	29369	29373	29377
1	5.27142	27151	27159	27167	27176	27184	1	5.29381	29386	29390	29394	29398	29402
2	5.27192	27201	27209	27217	27226	27234	2	5.29406	29410	29414	29418	29422	29426
3	5.27242	27250	27259	27267	27275	27283	3	5.29430	29434	29438	29441	29445	29449
4	5.27291	27299	27308	27316	27324	27332	4	5.29453	29457	29461	29465	29469	29472
5	5.27340	27348	27356	27364	27372	27380	5	5.29476	29480	29484	29488	29491	29495
6	5.27389	27396	27404	27412	27420	27428	6	5.29499	29503	29506	29510	29514	29517
7	5.27436	27444	27452	27460	27468	27476	7	5.29521	29525	29528	29532	29536	29539
8	5.27484	27492	27500	27507	27515	27523	8	5.29543	29546	29550	29554	29557	29561
9	5.27531	27539	27546	27554	27562	27570	9	5.29564	29568	29571	29575	29578	29582
10	5.27577	27585	27593	27601	27608	27616	10	5.29585	29589	29592	29596	29599	29602
11	5.27624	27631	27639	27647	27654	27662	11	5.29606	29609	29612	29616	29619	29623
12	5.27669	27677	27684	27692	27700	27707	12	5.29626	29629	29632	29636	29639	29642
13	5.27715	27722	27730	27737	27745	27752	13	5.29646	29649	29652	29655	29658	29662
14	5.27759	27767	27774	27782	27789	27796	14	5.29665	29668	29671	29674	29677	29681
15	5.27804	27811	27819	27826	27833	27840	15	5.29684	29687	29690	29693	29696	29699
16	5.27848	27855	27862	27870	27877	27884	16	5.29702	29705	29708	29711	29714	29717
17	5.27891	27899	27906	27913	27920	27927	17	5.29720	29723	29726	29729	29732	29735
18	5.27934	27942	27949	27956	27963	27970	18	5.29738	29741	29744	29747	29749	29752
19	5.27977	27984	27991	27998	28005	28012	19	5.29755	29758	29761	29764	29766	29769
20	5.28019	28026	28033	28040	28047	28054	20	5.29772	29775	29777	29780	29783	29786
21	5.28061	28068	28075	28082	28089	28096	21	5.29788	29791	29794	29796	29799	29802
22	5.28102	28109	28116	28123	28130	28137	22	5.29804	29807	29809	29812	29815	29817
23	5.28143	28150	28157	28164	28170	28177	23	5.29820	29822	29825	29827	29830	29832
24	5.28184	28191	28197	28204	28211	28217	24	5.29835	29837	29840	29842	29845	29847
25	5.28224	28231	28237	28244	28250	28257	25	5.29850	29852	29854	29857	29859	29861
26	5.28264	28270	28277	28283	28290	28296	26	5.29864	29866	29868	29871	29873	29875
27	5.28303	28309	28316	28322	28329	28335	27	5.29878	29880	29882	29884	29887	29889
28	5.28342	28348	28354	28361	28367	28374	28	5.29891	29893	29896	29898	29900	29902
29	5.28380	28386	28393	28399	28405	28411	29	5.29904	29906	29908	29911	29913	29915
30	5.28418	28424	28430	28437	28443	28449	30	5.29917	29919	29921	29923	29925	29927
31	5.28455	28461	28468	28474	28480	28486	31	5.29929	29931	29933	29935	29937	29939
32	5.28492	28498	28505	28511	28517	28523	32	5.29941	29943	29945	29947	29948	29950
33	5.28529	28535	28541	28547	28553	28559	33	5.29952	29954	29956	29958	29960	29961
34	5.28565	28571	28577	28583	28589	28595	34	5.29963	29965	29967	29969	29970	29972
35	5.28601	28607	28613	28619	28624	28630	35	5.29974	29975	29977	29979	29981	29982
36	5.28636	28642	28648	28654	28660	28665	36	5.29984	29986	29987	29989	29990	29992
37	5.28671	28677	28683	28688	28694	28700	37	5.29994	29995	29997	29998	30000	30001
38	5.28706	28711	28717	28723	28728	28734	38	5.30003	30004	30006	30007	30009	30010
39	5.28740	28745	28751	28757	28762	28768	39	5.30012	30013	30015	30016	30018	30019
40	5.28773	28779	28784	28790	28795	28801	40	5.30020	30022	30023	30024	30026	30027
41	5.28806	28812	28817	28823	28828	28834	41	5.30028	30030	30031	30032	30034	30035
42	5.28839	28845	28850	28855	28861	28866	42	5.30036	30037	30038	30040	30041	30042
43	5.28872	28877	28882	28888	28893	28898	43	5.30043	30044	30046	30047	30048	30049
44	5.28904	28909	28914	28919	28925	28930	44	5.30050	30051	30052	30053	30054	30055
45	5.28935	28940	28945	28951	28956	28961	45	5.30056	30058	30059	30060	30061	30062
46	5.28966	28971	28976	28981	28987	28992	46	5.30062	30063	30064	30065	30066	30067
47	5.28997	29002	29007	29012	29017	29022	47	5.30068	30069	30070	30071	30072	30072
48	5.29027	29032	29037	29042	29047	29052	48	5.30073	30074	30075	30076	30076	30077
49	5.29057	29062	29067	29072	29076	29081	49	5.30078	30079	30079	30080	30081	30082
50	5.29086	29091	29096	29101	29106	29110	50	5.30082	30083	30084	30084	30085	30086
51	5.29115	29120	29125	29129	29134	29139	51	5.30086	30087	30087	30088	30089	30089
52	5.29144	29148	29153	29158	29162	29167	52	5.30090	30090	30091	30091	30092	30092
53	5.29172	29176	29181	29186	29190	29195	53	5.30093	30093	30094	30094	30095	30095
54	5.29199	29204	29209	29213	29218	29222	54	5.30096	30096	30096	30097	30097	30097
55	5.29227	29231	29236	29240	29245	29249	55	5.30098	30098	30098	30099	30099	30099
56	5.29254	29258	29262	29267	29271	29276	56	5.30100	30100	30100	30100	30101	30101
57	5.29280	29284	29289	29293	29297	29302	57	5.30101	30101	30102	30102	30102	30102
58	5.29306	29310	29315	29319	29323	29327	58	5.30102	30102	30102	30103	30103	30103
59	5.29332	29336	29340	29344	29348	29353	59	5.30103	30103	30103	30103	30103	30103

TABLE XXIV.
OF NATURAL SINES.

159

	0°	1°	2°	3°	4°	
M	N sine	N cos	N sine	N cos	N sine	N cos
0	00000	100000	01745	99985	03490	99939
1	00029	100000	01771	99984	03517	99938
2	00058	100000	01797	99983	03544	99937
3	00087	100000	01823	99982	03571	99936
4	00116	100000	01849	99981	03598	99935
5	00145	100000	01875	99980	03625	99934
6	00173	100000	01901	99979	03652	99933
7	00202	100000	01927	99978	03679	99932
8	00231	100000	01953	99977	03706	99931
9	00259	100000	01979	99976	03733	99930
10	00288	100000	02005	99975	03760	99929
11	00317	99999	02031	99974	03787	99928
12	00345	99998	02057	99973	03814	99927
13	00374	99997	02083	99972	03841	99926
14	00403	99996	02109	99971	03868	99925
15	00431	99995	02135	99970	03895	99924
16	00460	99994	02161	99969	03922	99923
17	00488	99993	02187	99968	03949	99922
18	00517	99992	02213	99967	03976	99921
19	00545	99991	02239	99966	04003	99920
20	00574	99990	02265	99965	04030	99919
21	00602	99989	02291	99964	04057	99918
22	00631	99988	02317	99963	04084	99917
23	00659	99987	02343	99962	04111	99916
24	00688	99986	02369	99961	04138	99915
25	00716	99985	02395	99960	04165	99914
26	00745	99984	02421	99959	04192	99913
27	00773	99983	02447	99958	04219	99912
28	00802	99982	02473	99957	04246	99911
29	00830	99981	02499	99956	04273	99910
30	00859	99980	02525	99955	04300	99909
31	00887	99979	02551	99954	04327	99908
32	00916	99978	02577	99953	04354	99907
33	00944	99977	02603	99952	04381	99906
34	00973	99976	02629	99951	04408	99905
35	01001	99975	02655	99950	04435	99904
36	01030	99974	02681	99949	04462	99903
37	01058	99973	02707	99948	04489	99902
38	01087	99972	02733	99947	04516	99901
39	01115	99971	02759	99946	04543	99900
40	01144	99970	02785	99945	04570	99899
41	01172	99969	02811	99944	04597	99898
42	01201	99968	02837	99943	04624	99897
43	01229	99967	02863	99942	04651	99896
44	01258	99966	02889	99941	04678	99895
45	01286	99965	02915	99940	04705	99894
46	01315	99964	02941	99939	04732	99893
47	01343	99963	02967	99938	04759	99892
48	01372	99962	02993	99937	04786	99891
49	01400	99961	03019	99936	04813	99890
50	01429	99960	03045	99935	04840	99889
51	01457	99959	03071	99934	04867	99888
52	01486	99958	03097	99933	04894	99887
53	01514	99957	03123	99932	04921	99886
54	01543	99956	03149	99931	04948	99885
55	01571	99955	03175	99930	04975	99884
56	01600	99954	03201	99929	05002	99883
57	01628	99953	03227	99928	05029	99882
58	01657	99952	03253	99927	05056	99881
59	01685	99951	03279	99926	05083	99880
60	01714	99950	03305	99925	05110	99879
	N cos	N sine	N cos	N sine	N cos	N sine
	120°	60°	90°	30°	0°	330°

TABLE XXIV.
OF NATURAL SINES.

	5°		6°		7°		8°		9°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	08716	99619	10453	99452	12187	99253	13917	99027	15643	98769	60
1	08745	99617	10482	99449	12216	99251	13946	99023	15672	98764	59
2	08774	99614	10511	99446	12245	99248	13975	99019	15701	98760	58
3	08803	99612	10540	99443	12274	99244	14004	99015	15730	98755	57
4	08831	99609	10569	99440	12302	99240	14033	99011	15758	98751	56
5	08860	99607	10597	99437	12331	99237	14061	99006	15787	98746	55
6	08889	99604	10626	99434	12360	99233	14090	99002	15816	98741	54
7	08918	99602	10655	99431	12389	99230	14119	98998	15845	98737	53
8	08947	99599	10684	99428	12418	99226	14148	98994	15873	98732	52
9	08976	99596	10713	99424	12447	99222	14177	98990	15902	98728	51
10	09005	99594	10742	99421	12476	99219	14205	98986	15931	98723	50
11	09034	99591	10771	99418	12504	99215	14234	98982	15959	98718	49
12	09063	99588	10800	99415	12533	99211	14263	98978	15988	98714	48
13	09092	99586	10829	99412	12562	99208	14292	98973	16017	98709	47
14	09121	99583	10858	99409	12591	99204	14320	98969	16046	98704	46
15	09150	99580	10887	99406	12620	99200	14349	98965	16074	98700	45
16	09179	99578	10916	99402	12649	99197	14378	98961	16103	98695	44
17	09208	99575	10945	99399	12678	99193	14407	98957	16132	98690	43
18	09237	99572	10973	99396	12706	99189	14436	98953	16160	98686	42
19	09266	99570	11002	99393	12735	99186	14464	98948	16189	98681	41
20	09295	99567	11031	99390	12764	99182	14493	98944	16218	98676	40
21	09324	99564	11060	99386	12793	99178	14522	98940	16246	98671	39
22	09353	99562	11089	99383	12822	99175	14551	98936	16275	98667	38
23	09382	99559	11118	99380	12851	99171	14580	98931	16304	98662	37
24	09411	99556	11147	99377	12880	99167	14608	98927	16333	98657	36
25	09440	99553	11176	99374	12908	99163	14637	98923	16361	98652	35
26	09469	99551	11205	99370	12937	99160	14666	98919	16390	98648	34
27	09498	99548	11234	99367	12966	99156	14695	98914	16419	98643	33
28	09527	99545	11263	99364	12995	99152	14723	98910	16447	98638	32
29	09556	99542	11291	99360	13024	99148	14752	98906	16476	98633	31
30	09585	99540	11320	99357	13053	99144	14781	98902	16505	98629	30
31	09614	99537	11349	99354	13081	99141	14810	98897	16533	98624	29
32	09642	99534	11378	99351	13110	99137	14838	98893	16562	98619	28
33	09671	99531	11407	99347	13139	99133	14867	98889	16591	98614	27
34	09700	99528	11436	99344	13168	99129	14896	98884	16620	98609	26
35	09729	99526	11465	99341	13197	99125	14925	98880	16648	98604	25
36	09758	99523	11494	99337	13226	99122	14954	98876	16677	98600	24
37	09787	99520	11523	99334	13254	99118	14982	98871	16706	98595	23
38	09816	99517	11552	99331	13283	99114	15011	98867	16734	98590	22
39	09845	99514	11580	99327	13312	99110	15040	98863	16763	98585	21
40	09874	99511	11609	99324	13341	99106	15069	98858	16792	98580	20
41	09903	99508	11638	99320	13370	99102	15097	98854	16820	98575	19
42	09932	99506	11667	99317	13399	99098	15126	98849	16849	98570	18
43	09961	99503	11696	99314	13427	99094	15155	98845	16878	98565	17
44	09990	99500	11725	99310	13456	99091	15184	98841	16906	98561	16
45	10019	99497	11754	99307	13485	99087	15212	98836	16935	98556	15
46	10048	99494	11783	99303	13514	99083	15241	98832	16964	98551	14
47	10077	99491	11812	99300	13543	99079	15270	98827	16992	98546	13
48	10106	99488	11840	99297	13572	99075	15299	98823	17021	98541	12
49	10135	99485	11869	99293	13600	99071	15327	98818	17050	98536	11
50	10164	99482	11898	99290	13629	99067	15356	98814	17078	98531	10
51	10192	99479	11927	99286	13658	99063	15385	98809	17107	98526	9
52	10221	99476	11956	99283	13687	99059	15414	98805	17136	98521	8
53	10250	99473	11985	99279	13716	99055	15442	98800	17164	98516	7
54	10279	99470	12014	99276	13744	99051	15471	98796	17193	98511	6
55	10308	99467	12043	99272	13773	99047	15500	98791	17222	98506	5
56	10337	99464	12071	99269	13802	99043	15529	98787	17250	98501	4
57	10366	99461	12100	99265	13831	99039	15557	98782	17279	98496	3
58	10395	99458	12129	99262	13860	99035	15586	98778	17308	98491	2
59	10424	99455	12158	99258	13889	99031	15615	98773	17336	98486	1
60	10453	99452	12187	99255	13917	99027	15643	98769	17365	98481	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	84°		83°		82°		81°		80°		

161

	100°		110°		120°		130°		140°		
M	N. line	N. cos.	N. line	N. cos.	N. line	N. cos.	N. line	N. cos.	N. line	N. cos.	
0	17365	98481	19061	98163	20791	97816	22495	97437	24192	97038	60
1	17393	98476	19109	98157	20821	97809	22523	97430	24220	97023	59
2	17422	98471	19156	98152	20851	97803	22552	97423	24249	97016	58
3	17451	98466	19167	98146	20877	97797	22580	97417	24277	97008	57
4	17479	98461	19193	98140	20903	97791	22608	97411	24305	97001	56
5	17508	98455	19224	98133	20933	97784	22637	97404	24333	96994	55
6	17537	98450	19255	98129	20962	97778	22665	97398	24362	96987	54
7	17565	98445	19281	98124	20990	97772	22693	97391	24390	96980	53
8	17594	98440	19309	98118	21019	97766	22722	97384	24418	96973	52
9	17623	98435	19335	98112	21047	97760	22750	97378	24446	96966	51
10	17651	98430	19366	98107	21076	97754	22778	97371	24474	96959	50
11	17680	98425	19395	98101	21104	97748	22807	97365	24503	96952	49
12	17708	98420	19421	98096	21132	97742	22835	97358	24531	96945	48
13	17737	98414	19452	98090	21161	97735	22863	97351	24559	96937	47
14	17766	98409	19481	98084	21189	97729	22892	97345	24587	96930	46
15	17794	98404	19509	98079	21218	97723	22920	97338	24615	96923	45
16	17823	98399	19533	98073	21246	97717	22948	97331	24643	96916	44
17	17852	98394	19566	98067	21275	97711	22977	97325	24672	96909	43
18	17880	98389	19595	98061	21303	97705	23005	97318	24700	96902	42
19	17909	98383	19625	98056	21331	97698	23033	97311	24728	96894	41
20	17937	98378	19652	98050	21360	97692	23062	97304	24756	96887	40
21	17966	98373	19680	98044	21388	97686	23090	97298	24784	96880	39
22	17995	98368	19709	98039	21417	97680	23118	97291	24813	96873	38
23	18023	98362	19737	98033	21445	97673	23146	97284	24841	96866	37
24	18052	98357	19766	98027	21474	97667	23175	97278	24869	96858	36
25	18081	98352	19794	98021	21502	97661	23203	97271	24897	96851	35
26	18109	98347	19823	98016	21530	97655	23231	97264	24925	96844	34
27	18138	98341	19851	98010	21559	97649	23260	97257	24954	96837	33
28	18166	98336	19880	98004	21587	97642	23288	97251	24982	96829	32
29	18195	98331	19908	97998	21616	97636	23316	97244	25010	96822	31
30	18224	98325	19937	97992	21644	97630	23345	97237	25038	96815	30
31	18252	98320	19965	97987	21672	97623	23373	97230	25066	96807	29
32	18281	98315	19994	97981	21701	97617	23401	97223	25094	96800	28
33	18309	98310	20022	97975	21729	97611	23429	97217	25122	96793	27
34	18338	98304	20051	97969	21758	97604	23458	97210	25151	96786	26
35	18367	98299	20079	97963	21786	97598	23486	97203	25179	96778	25
36	18395	98294	20108	97958	21814	97592	23514	97196	25207	96771	24
37	18424	98288	20136	97952	21843	97585	23542	97189	25235	96764	23
38	18452	98283	20165	97946	21871	97579	23571	97182	25263	96756	22
39	18481	98277	20193	97940	21899	97573	23599	97176	25291	96749	21
40	18509	98272	20222	97934	21928	97566	23627	97169	25320	96742	20
41	18538	98267	20250	97928	21956	97560	23656	97162	25348	96734	19
42	18567	98261	20279	97922	21985	97553	23684	97155	25376	96727	18
43	18595	98256	20307	97916	22013	97547	23712	97148	25404	96719	17
44	18624	98250	20336	97910	22041	97541	23740	97141	25432	96712	16
45	18652	98245	20364	97905	22070	97534	23769	97134	25460	96705	15
46	18681	98240	20393	97899	22098	97528	23797	97127	25488	96697	14
47	18710	98234	20421	97893	22126	97521	23825	97120	25516	96690	13
48	18738	98229	20450	97887	22156	97515	23853	97113	25545	96682	12
49	18767	98223	20478	97881	22185	97508	23882	97106	25573	96675	11
50	18795	98217	20507	97875	22212	97502	23910	97100	25601	96667	10
51	18824	98212	20535	97869	22240	97496	23938	97093	25629	96660	9
52	18852	98207	20563	97863	22268	97489	23966	97086	25657	96653	8
53	18881	98201	20592	97857	22297	97483	23994	97079	25685	96646	7
54	18910	98196	20620	97851	22325	97476	24023	97072	25713	96638	6
55	18938	98190	20649	97845	22353	97470	24051	97065	25741	96630	5
56	18967	98185	20677	97839	22382	97463	24079	97058	25769	96623	4
57	18995	98179	20706	97833	22410	97457	24108	97051	25797	96615	3
58	19024	98174	20734	97827	22438	97450	24136	97044	25826	96608	2
59	19052	98168	20763	97821	22467	97443	24164	97037	25854	96600	1
60	19081	98163	20791	97815	22495	97437	24192	97030	25882	96593	0
N. cos. N. line N. cos. N. line N. cos. N. line N. cos. N. line N. cos. N. line											
79° 78° 77° 76° 75°											

TABLE XXIV.
OF NATURAL SINES.

	15°		16°		17°		18°		19°		
M	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	M
0	25832	96593	27564	96126	29237	95630	30902	95106	32557	94562	60
1	25910	96535	27692	96116	29265	95622	30929	95097	32584	94542	59
2	25986	96578	27820	96110	29291	95613	30957	95088	32612	94533	58
3	26066	96570	27948	96102	29321	95605	30985	95079	32639	94523	57
4	26141	96562	28076	96094	29348	95596	31012	95070	32667	94514	56
5	26222	96555	28204	96086	29376	95588	31040	95061	32694	94504	55
6	26300	96547	28331	96078	29404	95579	31068	95052	32722	94495	54
7	26379	96540	28459	96070	29432	95571	31095	95043	32749	94485	53
8	26457	96532	28587	96062	29460	95562	31123	95033	32777	94476	52
9	26535	96524	28715	96054	29487	95554	31151	95024	32804	94466	51
10	26613	96517	28843	96046	29515	95545	31178	95015	32832	94457	50
11	26691	96509	28971	96037	29543	95536	31206	95006	32859	94447	49
12	26769	96502	29099	96029	29571	95528	31233	94997	32887	94438	48
13	26847	96494	29227	96021	29599	95519	31261	94988	32914	94428	47
14	26925	96486	29355	96013	29626	95511	31289	94979	32942	94418	46
15	27003	96479	29483	96005	29654	95502	31316	94970	32969	94409	45
16	27081	96471	29611	95997	29682	95493	31344	94961	32997	94399	44
17	27159	96463	29739	95989	29710	95485	31372	94952	33024	94390	43
18	27237	96456	29867	95981	29737	95476	31399	94943	33051	94380	42
19	27315	96448	29995	95972	29765	95467	31427	94933	33079	94370	41
20	27393	96440	30123	95964	29793	95459	31454	94924	33106	94361	40
21	27471	96433	30251	95956	29821	95450	31482	94915	33134	94351	39
22	27549	96425	30379	95948	29849	95441	31510	94906	33161	94342	38
23	27627	96417	30507	95940	29876	95433	31537	94897	33189	94332	37
24	27705	96410	30635	95931	29904	95424	31565	94888	33216	94322	36
25	27783	96402	30763	95923	29932	95415	31593	94878	33244	94313	35
26	27861	96394	30891	95915	29960	95407	31620	94869	33271	94303	34
27	27939	96386	31019	95907	29987	95398	31648	94860	33299	94293	33
28	28017	96379	31147	95899	30015	95389	31675	94851	33326	94284	32
29	28095	96371	31275	95890	30043	95380	31703	94842	33353	94274	31
30	28173	96363	31403	95882	30071	95372	31730	94833	33381	94264	30
31	28251	96355	31531	95874	30099	95363	31758	94824	33408	94254	29
32	28329	96347	31659	95865	30126	95354	31786	94814	33436	94245	28
33	28407	96340	31787	95857	30154	95345	31813	94805	33463	94235	27
34	28485	96332	31915	95849	30182	95337	31841	94795	33490	94225	26
35	28563	96324	32043	95841	30209	95328	31868	94786	33518	94215	25
36	28641	96316	32171	95832	30237	95319	31896	94777	33545	94206	24
37	28719	96308	32299	95824	30265	95310	31923	94768	33573	94196	23
38	28797	96301	32427	95816	30292	95301	31951	94758	33600	94186	22
39	28875	96293	32555	95807	30320	95293	31979	94749	33627	94176	21
40	28953	96285	32683	95799	30348	95284	32006	94740	33655	94167	20
41	29031	96277	32811	95791	30376	95275	32034	94730	33682	94157	19
42	29109	96269	32939	95782	30403	95266	32061	94721	33710	94147	18
43	29187	96261	33067	95774	30431	95257	32089	94712	33737	94137	17
44	29265	96253	33195	95766	30459	95248	32116	94702	33764	94127	16
45	29343	96246	33323	95757	30486	95240	32144	94693	33792	94118	15
46	29421	96238	33451	95749	30514	95231	32171	94684	33819	94108	14
47	29499	96230	33579	95740	30542	95222	32199	94674	33846	94098	13
48	29577	96222	33707	95732	30570	95213	32227	94665	33874	94088	12
49	29655	96214	33835	95724	30597	95204	32254	94656	33901	94078	11
50	29733	96206	33963	95715	30625	95195	32282	94646	33929	94068	10
51	29811	96198	34091	95707	30653	95186	32309	94637	33956	94058	9
52	29889	96190	34219	95698	30680	95177	32337	94627	33983	94048	8
53	29967	96182	34347	95690	30708	95168	32364	94618	34011	94039	7
54	30045	96174	34475	95681	30736	95159	32392	94609	34038	94029	6
55	30123	96166	34603	95673	30763	95150	32419	94599	34065	94019	5
56	30201	96158	34731	95664	30791	95142	32447	94590	34093	94009	4
57	30279	96150	34859	95656	30819	95133	32474	94580	34120	93999	3
58	30357	96142	34987	95647	30846	95124	32502	94571	34147	93989	2
59	30435	96134	35115	95639	30874	95115	32529	94561	34175	93979	1
60	30513	96126	35243	95630	30902	95106	32557	94552	34202	93969	0
	N cos.	N.sine.	N cos.	N.sine.	N cos.	N.sine.	N cos.	N.sine.	N cos.	N.sine.	M
	74°		75°		76°		77°		78°		

TABLE XXIV.
OF NATURAL SINES.

163

	20°		21°		22°		23°		24°		
M	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	M.
0	34807	93969	35637	93558	37361	92718	39073	92000	40674	91353	60
1	34829	93959	35654	93548	37385	92707	39100	91989	40700	91343	59
2	34857	93949	35681	93537	37413	92697	39127	91978	40727	91332	58
3	34884	93939	35708	93527	37442	92686	39155	91966	40753	91321	57
4	34911	93929	35735	93516	37469	92675	39180	91955	40780	91310	56
5	34939	93919	35763	93506	37495	92664	39207	91944	40806	91299	55
6	34966	93909	35790	93495	37522	92653	39234	91932	40833	91288	54
7	34993	93899	35817	93485	37549	92642	39260	91921	40860	91277	53
8	35021	93889	35844	93474	37576	92631	39287	91910	40886	91266	52
9	35048	93879	35871	93464	37603	92620	39314	91899	40913	91255	51
10	35075	93869	35898	93453	37630	92609	39341	91888	40940	91244	50
11	35103	93859	35925	93443	37657	92598	39367	91877	40966	91233	49
12	35130	93849	35952	93432	37684	92587	39394	91866	40993	91222	48
13	35157	93839	35979	93422	37711	92576	39421	91855	41019	91211	47
14	35184	93829	36006	93411	37738	92565	39447	91844	41046	91200	46
15	35211	93819	36033	93401	37765	92554	39474	91833	41072	91189	45
16	35238	93809	36060	93390	37792	92543	39501	91822	41099	91178	44
17	35265	93799	36087	93380	37819	92532	39527	91811	41125	91167	43
18	35292	93789	36114	93369	37846	92521	39554	91800	41152	91156	42
19	35319	93779	36141	93359	37873	92510	39581	91789	41178	91145	41
20	35346	93769	36168	93348	37900	92499	39607	91778	41205	91134	40
21	35373	93759	36195	93338	37927	92488	39634	91767	41231	91123	39
22	35400	93749	36222	93327	37954	92477	39661	91756	41257	91112	38
23	35427	93739	36249	93316	37981	92466	39688	91745	41284	91101	37
24	35454	93729	36276	93306	38008	92455	39715	91734	41310	91090	36
25	35481	93719	36303	93295	38035	92444	39742	91723	41337	91079	35
26	35508	93709	36330	93285	38062	92433	39769	91712	41363	91068	34
27	35535	93699	36357	93274	38089	92422	39796	91701	41390	91057	33
28	35562	93689	36384	93264	38116	92411	39823	91690	41416	91046	32
29	35589	93679	36411	93253	38143	92400	39850	91679	41443	91035	31
30	35616	93669	36438	93243	38170	92389	39877	91668	41469	91024	30
31	35643	93659	36465	93232	38197	92378	39904	91657	41496	91013	29
32	35670	93649	36492	93222	38224	92367	39931	91646	41522	91002	28
33	35697	93639	36519	93211	38251	92356	39958	91635	41549	90991	27
34	35724	93629	36546	93201	38278	92345	39985	91624	41575	90980	26
35	35751	93619	36573	93190	38305	92334	40012	91613	41602	90969	25
36	35778	93609	36600	93180	38332	92323	40039	91602	41628	90958	24
37	35805	93599	36627	93169	38359	92312	40066	91591	41655	90947	23
38	35832	93589	36654	93159	38386	92301	40093	91580	41681	90936	22
39	35859	93579	36681	93148	38413	92290	40120	91569	41708	90925	21
40	35886	93569	36708	93138	38440	92279	40147	91558	41734	90914	20
41	35913	93559	36735	93127	38467	92268	40174	91547	41761	90903	19
42	35940	93549	36762	93117	38494	92257	40201	91536	41787	90892	18
43	35967	93539	36789	93106	38521	92246	40228	91525	41814	90881	17
44	35994	93529	36816	93096	38548	92235	40255	91514	41840	90870	16
45	36021	93519	36843	93085	38575	92224	40282	91503	41867	90859	15
46	36048	93509	36870	93075	38602	92213	40309	91492	41893	90848	14
47	36075	93499	36897	93064	38629	92202	40336	91481	41920	90837	13
48	36102	93489	36924	93054	38656	92191	40363	91470	41946	90826	12
49	36129	93479	36951	93043	38683	92180	40390	91459	41973	90815	11
50	36156	93469	36978	93033	38710	92169	40417	91448	42000	90804	10
51	36183	93459	37005	93022	38737	92158	40444	91437	42026	90793	9
52	36210	93449	37032	93012	38764	92147	40471	91426	42053	90782	8
53	36237	93439	37059	93001	38791	92136	40498	91415	42079	90771	7
54	36264	93429	37086	92991	38818	92125	40525	91404	42106	90760	6
55	36291	93419	37113	92980	38845	92114	40552	91393	42132	90749	5
56	36318	93409	37140	92970	38872	92103	40579	91382	42159	90738	4
57	36345	93399	37167	92959	38899	92092	40606	91371	42185	90727	3
58	36372	93389	37194	92949	38926	92081	40633	91360	42212	90716	2
59	36399	93379	37221	92938	38953	92070	40660	91349	42238	90705	1
60	36426	93369	37248	92928	38980	92059	40687	91338	42265	90694	0
N. cos. N. sine N. cos. N. sine N. cos. N. sine N. cos. N. sine N. cos. N. sine											M.
	69°		68°		67°		66°		65°		

TABLE XXIV.
OF NATURAL SINE.

	25		26		27		28		29		
M.	N. line	N. cos	N. line	N. cos	N. line	N. cos	N. line	N. cos	N. line	N. cos	
0	42263	90631	43837	19679	45399	19101	46917	89294	65451	87422	50
1	42281	90615	43863	29867	45425	19087	46947	89211	65446	87411	49
2	42315	90606	43869	39834	45431	19074	46991	89157	65452	87404	
3	42341	90594	43916	39841	45477	19061	47024	89114	65457	87420	57
4	42367	90582	43912	89878	45503	19015	47021	89114	65451	87406	56
5	42394	90569	43961	9116	45529	19003	47075	89226	65454	87391	55
6	42420	90557	43994	19805	45554	19011	47101	89113	65454	87377	54
7	42446	90545	44020	19790	45580	189006	47127	89113	65459	87363	53
8	42473	90532	44046	89777	45606	18903	47133	89113	65464	87349	52
9	42499	90520	44072	89764	45632	18981	47178	89113	65470	87335	51
10	42525	90507	44098	9752	45658	18968	47204	89113	65475	87321	50
11	42552	90495	44124	9739	45684	18955	47229	89114	65481	87306	49
12	42578	90483	44151	89726	45710	18942	47255	89113	65487	87292	48
13	42604	90470	44177	89713	45736	18929	47281	89117	65491	87278	47
14	42631	90458	44203	89700	45762	18915	47306	89103	65497	87264	46
15	42657	90446	44229	19657	45787	18902	47332	89099	65502	87250	45
16	42683	90433	44256	19671	45813	18886	47358	89075	65507	87236	44
17	42709	90421	44282	19662	45839	18871	47383	89062	65513	87221	43
18	42736	90408	44307	19654	45865	18857	47409	89051	65519	87207	42
19	42762	90396	44333	19646	45891	18841	47435	89034	65524	87193	41
20	42788	90383	44359	19631	45917	18825	47460	89020	65529	87178	40
21	42815	90371	44385	19610	45942	18812	47486	89006	65534	87164	39
22	42841	90358	44411	19597	45968	18800	47511	88993	65540	87150	38
23	42867	90346	44437	19581	45994	18785	47537	88979	65545	87136	37
24	42894	90334	44464	19571	46020	18782	47562	88965	65550	87121	36
25	42920	90321	44490	19558	46046	18766	47588	88951	65556	87107	35
26	42946	90309	44516	19545	46072	18753	47614	88937	65561	87093	34
27	42972	90296	44542	19532	46097	18741	47639	88923	65566	87079	33
28	42999	90284	44567	19519	46123	18727	47665	88909	65572	87064	32
29	43025	90271	44593	19506	46149	18715	47690	88896	65577	87050	31
30	43051	90259	44620	19493	46175	18701	47716	88882	65582	87036	30
31	43077	90246	44646	19480	46201	18686	47741	88868	65588	87021	29
32	43104	90233	44672	19467	46226	18674	47767	88854	65593	87007	28
33	43130	90221	44698	19454	46252	18661	47793	88840	65598	86993	27
34	43156	90208	44724	19441	46278	18647	47818	88826	65604	86978	26
35	43182	90196	44750	19427	46304	18634	47844	88812	65609	86964	25
36	43209	90183	44776	19415	46330	18620	47869	88798	65614	86949	24
37	43235	90171	44802	19402	46355	18607	47895	88784	65619	86935	23
38	43261	90158	44828	19389	46381	18593	47920	88770	65625	86921	22
39	43287	90146	44854	19376	46407	18580	47946	88756	65630	86906	21
40	43313	90133	44880	19363	46433	18566	47971	88743	65636	86892	20
41	43340	90120	44906	19350	46459	18553	47997	88729	65641	86878	19
42	43366	90108	44932	19337	46484	18539	48022	88715	65646	86863	18
43	43392	90095	44958	19324	46510	18526	48048	88701	65651	86849	17
44	43418	90082	44984	19311	46536	18512	48073	88687	65656	86834	16
45	43445	90070	45010	19298	46561	18499	48099	88673	65662	86820	15
46	43471	90057	45036	19285	46587	18485	48124	88659	65667	86806	14
47	43497	90045	45062	19272	46613	18472	48150	88645	65672	86791	13
48	43523	90032	45088	19259	46639	18458	48175	88631	65677	86777	12
49	43549	90019	45114	19246	46664	18445	48201	88617	65683	86762	11
50	43575	90007	45140	19233	46690	18431	48226	88603	65688	86748	10
51	43602	89994	45166	19219	46716	18417	48252	88589	65694	86733	9
52	43628	89981	45192	19206	46742	18404	48277	88575	65699	86719	8
53	43654	89968	45218	19193	46767	18390	48303	88561	65705	86704	7
54	43680	89956	45243	19180	46793	18377	48328	88546	65710	86690	6
55	43706	89943	45269	19167	46819	18363	48354	88532	65716	86675	5
56	43733	89930	45295	19153	46844	18349	48379	88518	65721	86661	4
57	43759	89918	45321	19140	46870	18336	48405	88504	65727	86646	3
58	43785	89905	45347	19127	46896	18322	48430	88490	65732	86632	2
59	43811	89892	45373	19114	46921	18309	48456	88476	65738	86617	1
60	43837	89879	45399	19101	46947	18295	48481	88462	65743	86603	0
N. cos. N. line N. cos. N. line N. cos. N. line N. cos. N. line N. cos. N. line											

TABLE XXIV.
OF NATURAL SINES.

165

	30°		31°		32°		33°		34°		
M	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	50000	86603	51504	85717	52992	84803	54464	83667	55919	82401	60
1	50025	86588	51529	85702	53017	84789	54488	83651	55943	82385	59
2	50050	86573	51554	85687	53041	84774	54513	83635	55968	82371	58
3	50076	86559	51579	85672	53066	84759	54537	83619	55992	82356	57
4	50101	86544	51604	85657	53091	84743	54561	83604	56016	82339	56
5	50126	86530	51628	85642	53115	84728	54586	83588	56040	82322	55
6	50151	86515	51653	85627	53140	84712	54610	83572	56064	82306	54
7	50176	86501	51677	85612	53164	84697	54635	83556	56088	82290	53
8	50201	86486	51702	85597	53189	84681	54659	83540	56112	82273	52
9	50227	86471	51728	85582	53214	84666	54683	83524	56136	82257	51
10	50252	86457	51753	85567	53238	84650	54708	83508	56160	82241	50
11	50277	86442	51777	85551	53263	84635	54732	83492	56184	82226	49
12	50302	86427	51803	85536	53287	84619	54756	83476	56208	82208	48
13	50327	86413	51828	85521	53312	84604	54781	83460	56232	82192	47
14	50352	86398	51852	85506	53337	84588	54805	83444	56256	82175	46
15	50377	86384	51877	85491	53361	84573	54829	83429	56280	82159	45
16	50403	86369	51902	85476	53386	84557	54854	83413	56305	82143	44
17	50428	86354	51927	85461	53411	84542	54878	83397	56329	82126	43
18	50453	86340	51952	85446	53435	84526	54902	83381	56353	82110	42
19	50478	86325	51977	85431	53460	84511	54927	83365	56377	82093	41
20	50503	86311	52002	85416	53484	84495	54951	83349	56401	82077	40
21	50528	86296	52026	85401	53509	84480	54975	83333	56425	82061	39
22	50553	86281	52051	85385	53534	84464	54999	83317	56449	82044	38
23	50578	86266	52076	85370	53558	84448	55024	83301	56473	82028	37
24	50603	86251	52101	85355	53583	84433	55048	83285	56497	82011	36
25	50628	86237	52126	85340	53607	84417	55072	83269	56521	81995	35
26	50653	86222	52151	85325	53632	84402	55097	83253	56545	81978	34
27	50679	86207	52175	85310	53656	84386	55121	83237	56569	81962	33
28	50704	86192	52200	85294	53681	84370	55145	83221	56593	81946	32
29	50729	86178	52225	85279	53705	84355	55169	83205	56617	81929	31
30	50754	86163	52250	85264	53730	84339	55194	83189	56641	81913	30
31	50779	86148	52275	85249	53754	84324	55218	83173	56665	81896	29
32	50804	86133	52299	85234	53779	84308	55242	83157	56689	81880	28
33	50829	86119	52324	85218	53804	84292	55266	83141	56713	81863	27
34	50854	86104	52349	85203	53828	84277	55291	83125	56736	81847	26
35	50879	86090	52374	85188	53853	84261	55315	83109	56760	81830	25
36	50904	86074	52399	85173	53877	84245	55339	83093	56784	81814	24
37	50929	86059	52423	85157	53902	84230	55363	83077	56808	81797	23
38	50954	86045	52448	85142	53926	84214	55388	83061	56832	81781	22
39	50979	86030	52473	85127	53951	84198	55412	83045	56856	81764	21
40	51004	86015	52498	85112	53975	84182	55436	83029	56880	81748	20
41	51029	86000	52522	85096	54000	84167	55460	83013	56904	81731	19
42	51054	85985	52547	85081	54024	84151	55484	82997	56928	81715	18
43	51079	85970	52572	85066	54049	84135	55509	82981	56952	81698	17
44	51104	85956	52597	85051	54073	84120	55533	82965	56976	81681	16
45	51129	85941	52621	85035	54097	84104	55557	82949	57000	81665	15
46	51154	85926	52646	85020	54122	84088	55581	82933	57024	81648	14
47	51179	85911	52671	85005	54146	84072	55605	82917	57047	81632	13
48	51204	85896	52696	84989	54171	84057	55630	82901	57071	81615	12
49	51229	85881	52720	84974	54195	84041	55654	82885	57095	81598	11
50	51254	85866	52745	84959	54220	84025	55678	82869	57119	81582	10
51	51279	85851	52770	84943	54244	84009	55702	82853	57143	81565	9
52	51304	85836	52794	84928	54269	83994	55726	82837	57167	81548	8
53	51329	85821	52819	84913	54293	83978	55750	82821	57191	81532	7
54	51354	85806	52844	84897	54317	83962	55775	82805	57215	81515	6
55	51379	85792	52869	84882	54342	83946	55799	82789	57239	81499	5
56	51404	85777	52893	84866	54366	83930	55823	82773	57263	81482	4
57	51429	85762	52918	84851	54391	83915	55847	82757	57287	81465	3
58	51454	85747	52943	84836	54415	83899	55871	82741	57311	81448	2
59	51479	85732	52967	84820	54440	83883	55895	82725	57335	81432	1
60	51504	85717	52992	84805	54464	83867	55919	82709	57359	81415	0
N. cos. N. sine. N. cos. N. sine. N. cos. N. sine. N. cos. N. sine. N. cos. N. sine.											M
	30°		31°		32°		33°		34°		

TABLE XXIV.
OF NATURAL SINES.

	35°		36°		37°		38°		39°		
M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	57358	81915	58779	80902	60182	79864	61566	78801	62932	77715	60
1	57381	81899	58802	80885	60205	79846	61589	78783	62955	77696	59
2	57405	81882	58826	80867	60228	79829	61612	78765	62977	77678	58
3	57429	81865	58849	80850	60251	79811	61635	78747	63000	77660	57
4	57453	81848	58873	80833	60274	79793	61658	78729	63022	77641	56
5	57477	81832	58896	80816	60298	79776	61681	78711	63045	77623	55
6	57501	81815	58920	80799	60321	79758	61704	78694	63068	77605	54
7	57524	81798	58943	80782	60344	79741	61726	78676	63090	77586	53
8	57548	81782	58967	80765	60367	79723	61749	78658	63113	77568	52
9	57572	81765	58990	80748	60390	79706	61772	78640	63135	77550	51
10	57596	81748	59014	80730	60414	79688	61795	78622	63158	77531	50
11	57619	81731	59037	80713	60437	79671	61818	78604	63180	77513	49
12	57643	81714	59061	80696	60460	79653	61841	78586	63203	77494	48
13	57667	81698	59084	80679	60483	79635	61864	78568	63225	77476	47
14	57691	81681	59108	80662	60506	79618	61887	78550	63248	77458	46
15	57715	81664	59131	80644	60529	79600	61909	78532	63271	77439	45
16	57738	81647	59154	80627	60553	79583	61932	78514	63293	77421	44
17	57762	81631	59178	80610	60576	79565	61955	78496	63316	77402	43
18	57786	81614	59201	80593	60599	79547	61978	78478	63338	77384	42
19	57810	81597	59225	80576	60622	79530	62001	78460	63361	77366	41
20	57833	81580	59248	80558	60645	79512	62024	78442	63383	77347	40
21	57857	81563	59272	80541	60668	79494	62046	78424	63406	77329	39
22	57881	81546	59295	80524	60691	79477	62069	78405	63428	77310	38
23	57904	81530	59318	80507	60714	79459	62092	78387	63451	77292	37
24	57928	81513	59342	80489	60738	79441	62115	78369	63473	77273	36
25	57952	81496	59365	80472	60761	79424	62138	78351	63496	77255	35
26	57976	81479	59389	80455	60784	79406	62160	78333	63518	77236	34
27	57999	81462	59412	80438	60807	79388	62183	78315	63540	77218	33
28	58023	81445	59436	80420	60830	79371	62206	78297	63563	77199	32
29	58047	81428	59459	80403	60853	79353	62229	78279	63585	77181	31
30	58070	81412	59482	80386	60876	79335	62251	78261	63608	77162	30
31	58094	81395	59506	80368	60899	79318	62274	78243	63630	77144	29
32	58118	81378	59529	80351	60922	79300	62297	78225	63653	77125	28
33	58141	81361	59552	80334	60945	79282	62320	78206	63675	77107	27
34	58165	81344	59576	80316	60968	79264	62342	78188	63698	77088	26
35	58189	81327	59599	80299	60991	79247	62365	78170	63720	77070	25
36	58212	81310	59622	80282	61015	79229	62388	78152	63742	77051	24
37	58236	81293	59646	80264	61038	79211	62411	78134	63765	77033	23
38	58260	81276	59669	80247	61061	79193	62433	78116	63787	77014	22
39	58283	81259	59693	80230	61084	79176	62456	78098	63810	76996	21
40	58307	81242	59716	80212	61107	79158	62479	78079	63832	76977	20
41	58330	81225	59739	80195	61130	79140	62502	78061	63854	76959	19
42	58354	81208	59763	80178	61153	79122	62524	78043	63877	76940	18
43	58378	81191	59786	80160	61176	79105	62547	78025	63899	76921	17
44	58401	81174	59809	80143	61199	79087	62570	78007	63922	76903	16
45	58425	81157	59832	80125	61222	79069	62592	77988	63944	76884	15
46	58449	81140	59856	80108	61245	79051	62615	77970	63966	76866	14
47	58472	81123	59879	80091	61268	79033	62638	77952	63989	76847	13
48	58496	81106	59902	80073	61291	79016	62660	77934	64011	76828	12
49	58519	81089	59926	80056	61314	78998	62683	77916	64033	76810	11
50	58543	81072	59949	80038	61337	78980	62706	77897	64056	76791	10
51	58567	81055	59972	80021	61360	78962	62728	77879	64078	76772	9
52	58590	81038	59995	80003	61383	78944	62751	77861	64100	76754	8
53	58614	81021	60019	79986	61406	78926	62774	77843	64123	76735	7
54	58637	81004	60042	79968	61429	78908	62796	77824	64145	76717	6
55	58661	80987	60065	79951	61451	78891	62819	77806	64167	76698	5
56	58684	80970	60089	79934	61474	78873	62842	77788	64190	76679	4
57	58708	80953	60112	79916	61497	78855	62864	77769	64212	76661	3
58	58731	80936	60135	79899	61520	78837	62887	77751	64234	76642	2
59	58755	80919	60158	79881	61543	78819	62909	77733	64256	76623	1
60	58779	80902	60182	79864	61566	78801	62932	77715	64279	76604	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.
	54°		53°		52°		51°		50°		

TABLE XXIV.
OF NATURAL SINES.

107

	40°		41°		42°		43°		44°		
M	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	M
0	64279	76604	63606	75471	66913	74314	68200	73135	69466	71934	60
1	64301	76586	63628	75452	66936	74295	68221	73116	69487	71914	59
2	64323	76567	63650	75433	66956	74276	68242	73096	69508	71894	58
3	64346	76548	63672	75414	66978	74256	68264	73076	69529	71873	57
4	64368	76530	63694	75395	66999	74237	68285	73056	69549	71853	56
5	64390	76511	63716	75375	67021	74217	68306	73036	69570	71833	55
6	64412	76492	63738	75356	67043	74198	68327	73016	69591	71813	54
7	64435	76473	63759	75337	67064	74178	68349	72996	69612	71792	53
8	64457	76454	63781	75318	67086	74159	68370	72976	69633	71772	52
9	64479	76436	63803	75299	67107	74139	68391	72957	69654	71752	51
10	64501	76417	63825	75280	67129	74120	68412	72937	69675	71732	50
11	64524	76398	63847	75261	67151	74100	68434	72917	69696	71711	49
12	64546	76380	63869	75241	67172	74080	68455	72897	69717	71691	48
13	64568	76361	63891	75222	67194	74061	68476	72877	69737	71671	47
14	64590	76342	63913	75203	67215	74041	68497	72857	69758	71650	46
15	64612	76323	63935	75184	67237	74022	68518	72837	69779	71630	45
16	64635	76304	63956	75165	67258	74002	68539	72817	69800	71610	44
17	64657	76286	63978	75146	67280	73983	68561	72797	69821	71590	43
18	64679	76267	64000	75126	67301	73963	68582	72777	69842	71569	42
19	64701	76248	64022	75107	67323	73944	68603	72757	69862	71549	41
20	64723	76229	64044	75088	67344	73924	68624	72737	69883	71529	40
21	64746	76210	64066	75069	67366	73904	68645	72717	69904	71508	39
22	64768	76192	64088	75050	67387	73885	68666	72697	69925	71488	38
23	64790	76173	64109	75030	67409	73865	68688	72677	69946	71468	37
24	64812	76154	64131	75011	67430	73846	68709	72657	69966	71447	36
25	64834	76135	64153	74992	67452	73826	68730	72637	69987	71427	35
26	64856	76116	64175	74973	67473	73806	68751	72617	70008	71407	34
27	64878	76097	64197	74953	67495	73787	68772	72597	70029	71386	33
28	64901	76078	64218	74934	67516	73767	68793	72577	70049	71366	32
29	64923	76059	64240	74915	67538	73747	68814	72557	70070	71345	31
30	64945	76041	64262	74896	67559	73728	68835	72537	70091	71325	30
31	64967	76022	64284	74876	67580	73708	68857	72517	70112	71305	29
32	64989	76003	64306	74857	67602	73688	68878	72497	70132	71284	28
33	65011	75984	64328	74838	67623	73669	68899	72477	70153	71264	27
34	65033	75965	64349	74818	67645	73649	68920	72457	70174	71243	26
35	65055	75946	64371	74799	67666	73629	68941	72437	70195	71223	25
36	65077	75927	64393	74780	67688	73610	68962	72417	70215	71203	24
37	65100	75908	64414	74760	67709	73590	68983	72397	70236	71182	23
38	65122	75889	64436	74741	67730	73570	69004	72377	70257	71162	22
39	65144	75870	64457	74722	67752	73551	69025	72357	70277	71141	21
40	65166	75851	64480	74703	67773	73531	69046	72337	70298	71121	20
41	65188	75832	64501	74683	67795	73511	69067	72317	70319	71100	19
42	65210	75813	64523	74664	67816	73491	69088	72297	70339	71080	18
43	65232	75794	64545	74644	67837	73472	69109	72277	70360	71059	17
44	65254	75775	64566	74625	67859	73452	69130	72257	70381	71039	16
45	65276	75756	64588	74606	67880	73432	69151	72236	70401	71019	15
46	65298	75738	64610	74586	67901	73413	69172	72216	70422	70998	14
47	65320	75719	64632	74567	67923	73393	69193	72196	70443	70978	13
48	65342	75700	64653	74548	67944	73373	69214	72176	70463	70957	12
49	65364	75680	64675	74528	67965	73353	69235	72156	70484	70937	11
50	65386	75661	64697	74509	67987	73333	69256	72136	70505	70916	10
51	65408	75642	64718	74489	68008	73314	69277	72116	70525	70896	9
52	65430	75623	64740	74470	68029	73294	69298	72095	70546	70875	8
53	65452	75604	64762	74451	68051	73274	69319	72075	70567	70855	7
54	65474	75585	64783	74431	68072	73254	69340	72055	70587	70834	6
55	65496	75566	64805	74412	68093	73234	69361	72035	70608	70813	5
56	65518	75547	64827	74392	68115	73215	69382	72015	70628	70793	4
57	65540	75528	64848	74373	68136	73195	69403	71995	70649	70772	3
58	65562	75509	64870	74353	68157	73175	69424	71974	70670	70752	2
59	65584	75490	64891	74334	68179	73155	69445	71954	70690	70731	1
60	65606	75471	64913	74314	68200	73135	69466	71934	70711	70711	0
	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	M.
	40°		40°		41°		41°		42°		

TABLE XXV.

Of Logarithmic Sines, Tangents, and Secants to every Point and Quarter Point of the Compass.

Points.	Sine.	Co. sine.	Tangent.	Co tang.	Secant.	Co. secant	
0	Inf. neg.	10.00000	Inf. neg.	Infinite.	10.00000	Infinite.	8
0 1/4	8.69080	9.99948	8.69132	11.30868	10.00052	11.30920	7 1/4
0 1/2	8.99130	9.99790	8.99340	11.00660	10.00000	11.00870	7 1/2
0 3/4	9.16652	9.99527	9.17125	10.82875	10.00473	10.83348	7 3/4
1	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	7
1 1/4	9.38557	9.98679	9.39879	10.60121	10.01321	10.61443	6 3/4
1 1/2	9.46282	9.98088	9.48194	10.51806	10.01912	10.53718	6 1/2
1 3/4	9.52749	9.97384	9.55365	10.44635	10.02616	10.47251	6 1/4
2	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	6
2 1/4	9.63099	9.95616	9.67483	10.32517	10.04384	10.36901	5 3/4
2 1/2	9.67339	9.94543	9.72796	10.27200	10.05457	10.32661	5 1/2
2 3/4	9.71105	9.93335	9.77770	10.22230	10.06665	10.28895	5 1/4
3	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	5
3 1/4	9.77503	9.90483	9.87020	10.12980	10.09517	10.22497	4 3/4
3 1/2	9.80236	9.88819	9.91417	10.08583	10.11181	10.19764	4 1/2
3 3/4	9.82708	9.86979	9.95729	10.04271	10.13021	10.17292	4 1/4
4	9.84949	9.84949	10.00000	10.00000	10.15051	10.15051	4
	Co. sine.	Sine	Co. tang.	Tangent.	Co. secant	Secant.	Points.

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 1—100.				Log. 0.00000—2.00000.					
N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.00000	21	1.32222	41	1.61278	61	1.78533	81	1.90849
2	0.30103	22	1.34242	42	1.62325	62	1.79239	82	1.91381
3	0.47712	23	1.36173	43	1.63347	63	1.79934	83	1.91908
4	0.60206	24	1.38021	44	1.64345	64	1.80618	84	1.92428
5	0.69897	25	1.39794	45	1.65321	65	1.81291	85	1.92941
6	0.77815	26	1.41497	46	1.66276	66	1.81954	86	1.93448
7	0.84510	27	1.43136	47	1.67210	67	1.82607	87	1.93952
8	0.90309	28	1.44716	48	1.68124	68	1.83251	88	1.94448
9	0.95424	29	1.46240	49	1.69020	69	1.83885	89	1.94939
10	1.00000	30	1.47712	50	1.69897	70	1.84510	90	1.95424
11	1.04139	31	1.49136	51	1.70757	71	1.85126	91	1.95904
12	1.07918	32	1.50515	52	1.71600	72	1.85733	92	1.96379
13	1.11394	33	1.51851	53	1.72428	73	1.86332	93	1.96848
14	1.14613	34	1.53148	54	1.73239	74	1.86923	94	1.97313
15	1.17609	35	1.54407	55	1.74036	75	1.87506	95	1.97772
16	1.20412	36	1.55630	56	1.74819	76	1.88081	96	1.98227
17	1.23045	37	1.56820	57	1.75587	77	1.88649	97	1.98677
18	1.25527	38	1.57978	58	1.76343	78	1.89209	98	1.99123
19	1.27875	39	1.59106	59	1.77085	79	1.89763	99	1.99564
20	1.30103	40	1.60206	60	1.77818	80	1.90309	100	2.00000

TABLE XXVI.

169

LOGARITHMS OF NUMBERS.

No. 100—1600.

Log. 00000—20412.

No.	0	1	2	3	4	5	6	7	8	9
100	00000	00043	00087	00130	00173	00217	00260	00303	00346	00389
101	00432	00475	00518	00561	00604	00647	00689	00732	00775	00817
102	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242
103	01284	01326	01368	01410	01452	01494	01536	01578	01620	01662
104	01703	01745	01787	01828	01870	01912	01953	01995	02036	02078
105	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490
106	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898
107	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302
108	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703
109	03743	03783	03822	03862	03902	03941	03981	04021	04060	04100
110	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493
111	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883
112	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269
113	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652
114	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032
115	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408
116	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781
117	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151
118	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518
119	07555	07591	07628	07664	07700	07737	07773	07809	07846	07882
120	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243
121	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600
122	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955
123	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307
124	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656
125	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003
126	10037	10072	10106	10140	10175	10209	10243	10278	10312	10346
127	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687
128	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025
129	11059	11093	11126	11160	11193	11227	11261	11294	11327	11361
130	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694
131	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024
132	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352
133	12385	12418	12450	12483	12516	12548	12581	12613	12646	12678
134	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001
135	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322
136	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640
137	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956
138	13987	14019	14051	14082	14114	14145	14176	14208	14239	14270
139	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582
140	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891
141	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198
142	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503
143	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806
144	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107
145	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406
146	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702
147	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997
148	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289
149	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580
150	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869
151	17893	17926	17955	17984	18013	18041	18070	18099	18127	18156
152	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441
153	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724
154	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005
155	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285
156	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562
157	19590	19618	19645	19673	19700	19728	19756	19783	19811	19838
158	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20385
No.	0	1	2	3	4	5	6	7	8	9

LOGARITHMS OF NUMBERS.

No. 1600—2200.

Log. 20412—34242.

No.	0	1	2	3	4	5	6	7	8	9
160	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656
161	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925
162	20952	20978	21005	21032	21059	21085	21112	21139	21165	21192
163	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458
164	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722
165	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985
166	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246
167	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505
168	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763
169	22739	22814	22840	22866	22891	22917	22943	22968	22994	23019
170	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274
171	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528
172	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779
173	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030
174	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279
175	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527
176	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773
177	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018
178	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261
179	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503
180	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744
181	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983
182	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221
183	26245	26269	26293	26316	26340	26364	26387	26411	26435	26458
184	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694
185	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928
186	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161
187	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393
188	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623
189	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852
190	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081
191	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307
192	28330	28353	28375	28398	28421	28443	28466	28488	28511	28533
193	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758
194	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981
195	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203
196	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425
197	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645
198	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863
199	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081
200	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298
201	30320	30341	30363	30384	30406	30428	30449	30471	30492	30514
202	30535	30557	30578	30600	30621	30643	30664	30685	30707	30728
203	30750	30771	30792	30814	30835	30856	30878	30899	30920	30942
204	30963	30984	31006	31027	31048	31069	31091	31112	31133	31154
205	31175	31197	31218	31239	31260	31281	31302	31323	31345	31366
206	31387	31408	31429	31450	31471	31492	31513	31534	31555	31576
207	31597	31618	31639	31660	31681	31702	31723	31744	31765	31785
208	31806	31827	31848	31869	31890	31911	31931	31952	31973	31994
209	32015	32035	32056	32077	32098	32118	32139	32160	32181	32201
210	32222	32243	32263	32284	32305	32325	32346	32366	32387	32408
211	32428	32449	32469	32490	32510	32531	32552	32572	32593	32613
212	32634	32654	32675	32695	32715	32736	32756	32777	32797	32818
213	32838	32858	32879	32899	32919	32940	32960	32980	33001	33021
214	33041	33062	33082	33102	33122	33143	33163	33183	33203	33224
215	33244	33264	33284	33304	33325	33345	33365	33385	33405	33425
216	33445	33465	33486	33506	33526	33546	33566	33586	33606	33626
217	33646	33666	33686	33706	33726	33746	33766	33786	33806	33826
218	33846	33866	33885	33905	33925	33945	33965	33985	34005	34025
219	34044	34064	34084	34104	34124	34143	34163	34183	34203	34223
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

171

LOGARITHMS OF NUMBERS.

No. 2200—2800					Log 34242—44716.					
No	0	1	2	3	4	5	6	7	8	9
220	31242	31257	31272	31287	31302	31317	31332	31347	31362	31377
221	31392	31407	31422	31437	31452	31467	31482	31497	31512	31527
222	31542	31557	31572	31587	31602	31617	31632	31647	31662	31677
223	31692	31707	31722	31737	31752	31767	31782	31797	31812	31827
224	31842	31857	31872	31887	31902	31917	31932	31947	31962	31977
225	31992	32007	32022	32037	32052	32067	32082	32097	32112	32127
226	32142	32157	32172	32187	32202	32217	32232	32247	32262	32277
227	32292	32307	32322	32337	32352	32367	32382	32397	32412	32427
228	32442	32457	32472	32487	32502	32517	32532	32547	32562	32577
229	32592	32607	32622	32637	32652	32667	32682	32697	32712	32727
230	32742	32757	32772	32787	32802	32817	32832	32847	32862	32877
231	32892	32907	32922	32937	32952	32967	32982	32997	33012	33027
232	33042	33057	33072	33087	33102	33117	33132	33147	33162	33177
233	33192	33207	33222	33237	33252	33267	33282	33297	33312	33327
234	33342	33357	33372	33387	33402	33417	33432	33447	33462	33477
235	33492	33507	33522	33537	33552	33567	33582	33597	33612	33627
236	33642	33657	33672	33687	33702	33717	33732	33747	33762	33777
237	33792	33807	33822	33837	33852	33867	33882	33897	33912	33927
238	33942	33957	33972	33987	34002	34017	34032	34047	34062	34077
239	34092	34107	34122	34137	34152	34167	34182	34197	34212	34227
240	34242	34257	34272	34287	34302	34317	34332	34347	34362	34377
241	34392	34407	34422	34437	34452	34467	34482	34497	34512	34527
242	34542	34557	34572	34587	34602	34617	34632	34647	34662	34677
243	34692	34707	34722	34737	34752	34767	34782	34797	34812	34827
244	34842	34857	34872	34887	34902	34917	34932	34947	34962	34977
245	34992	35007	35022	35037	35052	35067	35082	35097	35112	35127
246	35142	35157	35172	35187	35202	35217	35232	35247	35262	35277
247	35292	35307	35322	35337	35352	35367	35382	35397	35412	35427
248	35442	35457	35472	35487	35502	35517	35532	35547	35562	35577
249	35592	35607	35622	35637	35652	35667	35682	35697	35712	35727
250	35742	35757	35772	35787	35802	35817	35832	35847	35862	35877
251	35892	35907	35922	35937	35952	35967	35982	35997	36012	36027
252	36042	36057	36072	36087	36102	36117	36132	36147	36162	36177
253	36192	36207	36222	36237	36252	36267	36282	36297	36312	36327
254	36342	36357	36372	36387	36402	36417	36432	36447	36462	36477
255	36492	36507	36522	36537	36552	36567	36582	36597	36612	36627
256	36642	36657	36672	36687	36702	36717	36732	36747	36762	36777
257	36792	36807	36822	36837	36852	36867	36882	36897	36912	36927
258	36942	36957	36972	36987	37002	37017	37032	37047	37062	37077
259	37092	37107	37122	37137	37152	37167	37182	37197	37212	37227
260	37242	37257	37272	37287	37302	37317	37332	37347	37362	37377
261	37392	37407	37422	37437	37452	37467	37482	37497	37512	37527
262	37542	37557	37572	37587	37602	37617	37632	37647	37662	37677
263	37692	37707	37722	37737	37752	37767	37782	37797	37812	37827
264	37842	37857	37872	37887	37902	37917	37932	37947	37962	37977
265	37992	38007	38022	38037	38052	38067	38082	38097	38112	38127
266	38142	38157	38172	38187	38202	38217	38232	38247	38262	38277
267	38292	38307	38322	38337	38352	38367	38382	38397	38412	38427
268	38442	38457	38472	38487	38502	38517	38532	38547	38562	38577
269	38592	38607	38622	38637	38652	38667	38682	38697	38712	38727
270	38742	38757	38772	38787	38802	38817	38832	38847	38862	38877
271	38892	38907	38922	38937	38952	38967	38982	38997	39012	39027
272	39042	39057	39072	39087	39102	39117	39132	39147	39162	39177
273	39192	39207	39222	39237	39252	39267	39282	39297	39312	39327
274	39342	39357	39372	39387	39402	39417	39432	39447	39462	39477
275	39492	39507	39522	39537	39552	39567	39582	39597	39612	39627
276	39642	39657	39672	39687	39702	39717	39732	39747	39762	39777
277	39792	39807	39822	39837	39852	39867	39882	39897	39912	39927
278	39942	39957	39972	39987	40002	40017	40032	40047	40062	40077
279	40092	40107	40122	40137	40152	40167	40182	40197	40212	40227
280	40242	40257	40272	40287	40302	40317	40332	40347	40362	40377
281	40392	40407	40422	40437	40452	40467	40482	40497	40512	40527
282	40542	40557	40572	40587	40602	40617	40632	40647	40662	40677
283	40692	40707	40722	40737	40752	40767	40782	40797	40812	40827
284	40842	40857	40872	40887	40902	40917	40932	40947	40962	40977
285	40992	41007	41022	41037	41052	41067	41082	41097	41112	41127
286	41142	41157	41172	41187	41202	41217	41232	41247	41262	41277
287	41292	41307	41322	41337	41352	41367	41382	41397	41412	41427
288	41442	41457	41472	41487	41502	41517	41532	41547	41562	41577
289	41592	41607	41622	41637	41652	41667	41682	41697	41712	41727
290	41742	41757	41772	41787	41802	41817	41832	41847	41862	41877
291	41892	41907	41922	41937	41952	41967	41982	41997	42012	42027
292	42042	42057	42072	42087	42102	42117	42132	42147	42162	42177
293	42192	42207	42222	42237	42252	42267	42282	42297	42312	42327
294	42342	42357	42372	42387	42402	42417	42432	42447	42462	42477
295	42492	42507	42522	42537	42552	42567	42582	42597	42612	42627
296	42642	42657	42672	42687	42702	42717	42732	42747	42762	42777
297	42792	42807	42822	42837	42852	42867	42882	42897	42912	42927
298	42942	42957	42972	42987	43002	43017	43032	43047	43062	43077
299	43092	43107	43122	43137	43152	43167	43182	43197	43212	43227
300	43242	43257	43272	43287	43302	43317	43332	43347	43362	43377
301	43392	43407	43422	43437	43452	43467	43482	43497	43512	43527
302	43542	43557	43572	43587	43602	43617	43632	43647	43662	43677
303	43692	43707	43722	43737	43752	43767	43782	43797	43812	43827
304	43842	43857	43872	43887	43902	43917	43932	43947	43962	43977
305	43992	44007	44022	44037	44052	44067	44082	44097	44112	44127
306	44142	44157	44172	44187	44202	44217	44232	44247	44262	44277
307	44292	44307	44322	44337	44352	44367	44382	44397	44412	44427
308	44442	44457	44472	44487	44502	44517	44532	44547	44562	44577
309	44592	44607	44622	44637	44652	44667	44682	44697	44712	44727
310	44742	44757	44772	44787	44802	44817	44832	44847	44862	44877
311	44892	44907	44922	44937	44952	44967	44982	44997	45012	45027
312	45042	45057	45072	45087	45102	45117	45132	45147	45162	45177
313	45192	45207	45222	45237	45252	45267	45282	45297	45312	45327
314	45342	45357	45372	45387	45402	45417	45432	45447	45462	45477
315	45492	45507	45522	45537	45552	45567	45582	45597	45612	45627
316	45642	45657	45672	45687	45702	45717	45732	45747	45762	45777
317	45792	45807	45822	45837	45852	45867	45882	45897	45912	45927
318	45942	45957	45972	45987	46002	46017	46032	46047	46062	46077
319	46092	46107	46122	46137	46152	46167	46182	46197	46212	46227
320	46242	46257	46272	46287	46302	46317	46332	46347	46362	46377
321	46392	46407	46422	46437	46452	46467	46482	46497	46512	46527
322	46542	46557	46572	46587	46602	46617	46632	46647	46662	46677
323	46692	46707	46722	46737	46752	46767	46782	46797	46812	46827
324	46842	46857	46872	46887	46902	46917	46932	46947	46962	46977
325	46992	47007	47022	47037	47052	47067	47082	47097	47112	47127
326	47142	47157	47172	47187	47202	4721				

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 2800—3400.					Log. 44716—53148.					
No.	0	1	2	3	4	5	6	7	8	9
280	44716	44731	44747	44762	44778	44793	44809	44824	44840	44855
281	44871	44886	44902	44917	44932	44948	44963	44979	44994	45010
282	45025	45040	45056	45071	45086	45102	45117	45133	45148	45163
283	45179	45194	45209	45225	45240	45255	45271	45286	45301	45317
284	45332	45347	45362	45378	45393	45408	45423	45439	45454	45469
285	45484	45500	45515	45530	45545	45561	45576	45591	45606	45621
286	45637	45652	45667	45682	45697	45712	45728	45743	45758	45773
287	45788	45803	45818	45834	45849	45864	45879	45894	45909	45924
288	45939	45954	45969	45984	46000	46015	46030	46045	46060	46075
289	46090	46105	46120	46135	46150	46165	46180	46195	46210	46225
290	46240	46255	46270	46285	46300	46315	46330	46345	46359	46374
291	46389	46404	46419	46434	46449	46464	46479	46494	46509	46523
292	46538	46553	46568	46583	46598	46613	46627	46642	46657	46672
293	46687	46702	46716	46731	46746	46761	46776	46790	46805	46820
294	46835	46850	46864	46879	46894	46909	46923	46938	46953	46967
295	46982	46997	47012	47026	47041	47056	47070	47085	47100	47114
296	47129	47144	47159	47173	47188	47202	47217	47232	47246	47261
297	47276	47290	47305	47319	47334	47349	47363	47378	47392	47407
298	47422	47436	47451	47465	47480	47494	47509	47524	47538	47553
299	47567	47582	47596	47611	47625	47640	47654	47669	47683	47698
300	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842
301	47857	47871	47885	47900	47914	47929	47943	47958	47972	47986
302	48001	48015	48029	48044	48058	48073	48087	48101	48116	48130
303	48144	48159	48173	48187	48202	48216	48230	48244	48259	48273
304	48287	48302	48316	48330	48344	48359	48373	48387	48401	48416
305	48430	48444	48458	48473	48487	48501	48515	48530	48544	48558
306	48572	48586	48601	48615	48629	48643	48657	48671	48686	48700
307	48714	48728	48742	48756	48770	48785	48799	48813	48827	48841
308	48855	48869	48883	48897	48911	48926	48940	48954	48968	48982
309	48996	49010	49024	49038	49052	49066	49080	49094	49108	49122
310	49136	49150	49164	49178	49192	49206	49220	49234	49248	49262
311	49276	49290	49304	49318	49332	49346	49360	49374	49388	49402
312	49415	49429	49443	49457	49471	49485	49499	49513	49527	49541
313	49554	49568	49582	49596	49610	49624	49638	49651	49665	49679
314	49693	49707	49721	49734	49748	49762	49776	49790	49803	49817
315	49831	49845	49859	49872	49886	49900	49914	49927	49941	49955
316	49969	49982	49996	50010	50024	50037	50051	50065	50079	50092
317	50106	50120	50133	50147	50161	50174	50188	50202	50215	50229
318	50243	50256	50270	50284	50297	50311	50325	50338	50352	50365
319	50379	50393	50406	50420	50433	50447	50461	50474	50488	50501
320	50515	50529	50542	50556	50569	50583	50596	50610	50623	50637
321	50651	50664	50678	50691	50705	50718	50732	50745	50759	50772
322	50786	50799	50813	50826	50840	50853	50866	50880	50893	50907
323	50920	50934	50947	50961	50974	50987	51001	51014	51028	51041
324	51055	51068	51081	51095	51108	51121	51135	51148	51162	51175
325	51188	51202	51215	51228	51242	51255	51268	51282	51295	51308
326	51322	51335	51348	51362	51375	51388	51402	51415	51428	51441
327	51455	51468	51481	51495	51508	51521	51534	51548	51561	51574
328	51587	51601	51614	51627	51640	51654	51667	51680	51693	51706
329	51720	51733	51746	51759	51772	51786	51799	51812	51825	51838
330	51851	51865	51878	51891	51904	51917	51930	51943	51957	51970
331	51983	51996	52009	52022	52035	52048	52061	52075	52088	52101
332	52111	52127	52140	52153	52166	52179	52192	52205	52218	52231
333	52244	52257	52270	52281	52297	52310	52323	52336	52349	52362
334	52375	52388	52401	52414	52427	52440	52453	52466	52479	52492
335	52501	52517	52530	52543	52556	52569	52582	52595	52608	52621
336	52634	52647	52660	52673	52686	52699	52711	52724	52737	52750
337	52763	52776	52789	52802	52815	52827	52840	52853	52866	52879
338	52892	52905	52917	52930	52943	52956	52969	52982	52994	53007
339	53020	53033	53046	53058	53071	53084	53097	53110	53122	53135
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

173

LOGARITHMS OF NUMBERS.

No. 4000 ————— Log 60000										
No	0	1	2	3	4	5	6	7	8	9
340	3 4	53161	53173	53186	53199	53212	53224	53237	53250	53263
341	53275	53288	53301	53314	53326	53339	53352	53364	53377	53390
342	53403	53415	53428	53441	53453	53466	53479	53491	53504	53517
343	53529	53542	53555	53567	53580	53593	53605	53618	53631	53643
344	53656	53668	53681	53694	53706	53719	53732	53744	53757	53769
345	53782	53794	53807	53820	53832	53845	53857	53870	53882	53895
346	53908	53920	53933	53945	53958	53970	53983	53995	54008	54020
347	54033	54045	54058	54070	54083	54095	54108	54120	54133	54145
348	54158	54170	54183	54195	54208	54220	54233	54245	54258	54270
349	54283	54295	54307	54320	54332	54345	54357	54370	54382	54395
350	54407	54419	54432	54444	54456	54469	54481	54494	54506	54518
351	54531	54543	54555	54568	54580	54593	54605	54618	54630	54643
352	54654	54667	54679	54691	54704	54716	54728	54741	54753	54765
353	54777	54790	54802	54814	54827	54839	54851	54864	54876	54888
354	54900	54913	54925	54937	54949	54962	54974	54986	54998	55011
355	55023	55035	55047	55060	55072	55084	55096	55108	55121	55133
356	55145	55157	55169	55182	55194	55206	55218	55230	55242	55255
357	55267	55279	55291	55303	55315	55327	55340	55352	55364	55376
358	55388	55400	55413	55425	55437	55449	55461	55473	55485	55497
359	55509	55522	55534	55546	55558	55570	55582	55594	55606	55618
360	55630	55642	55654	55666	55678	55691	55703	55715	55727	55739
361	55751	55763	55775	55787	55799	55811	55823	55835	55847	55859
362	55871	55883	55895	55907	55919	55931	55943	55955	55967	55979
363	55991	56003	56015	56027	56039	56051	56063	56075	56087	56099
364	56110	56122	56134	56146	56158	56170	56182	56194	56206	56217
365	56229	56241	56253	56265	56277	56289	56301	56313	56324	56336
366	56348	56360	56372	56384	56396	56407	56419	56431	56443	56455
367	56467	56479	56490	56502	56514	56526	56538	56549	56561	56573
368	56585	56597	56608	56620	56632	56644	56656	56667	56679	56691
369	56703	56715	56726	56738	56750	56761	56773	56785	56797	56808
370	56820	56832	56844	56855	56867	56879	56891	56902	56914	56926
371	56937	56949	56961	56972	56984	56996	57007	57019	57031	57043
372	57054	57066	57078	57089	57101	57113	57124	57136	57147	57159
373	57171	57183	57194	57206	57217	57229	57241	57252	57264	57276
374	57287	57299	57310	57322	57334	57345	57357	57368	57380	57392
375	57403	57415	57426	57438	57449	57461	57473	57484	57496	57507
376	57519	57530	57542	57553	57565	57576	57588	57599	57611	57623
377	57634	57646	57657	57669	57680	57692	57703	57715	57726	57738
378	57749	57761	57772	57784	57795	57807	57818	57830	57841	57853
379	57864	57875	57887	57898	57910	57921	57933	57944	57955	57967
380	57978	57990	58001	58013	58024	58035	58047	58058	58070	58081
381	58092	58104	58115	58127	58138	58149	58161	58172	58184	58195
382	58206	58218	58229	58240	58252	58263	58274	58286	58297	58309
383	58320	58331	58343	58354	58365	58377	58388	58399	58410	58422
384	58433	58444	58456	58467	58478	58490	58501	58512	58524	58535
385	58546	58557	58569	58580	58591	58602	58614	58625	58636	58647
386	58658	58670	58681	58692	58704	58715	58726	58737	58749	58760
387	58771	58782	58794	58805	58816	58827	58838	58850	58861	58872
388	58883	58894	58906	58917	58928	58939	58950	58961	58973	58984
389	58995	59006	59017	59028	59040	59051	59062	59073	59084	59095
390	59106	59118	59129	59140	59151	59162	59173	59184	59195	59207
391	59218	59229	59240	59251	59262	59273	59284	59295	59306	59317
392	59328	59340	59351	59362	59373	59384	59395	59406	59417	59428
393	59439	59450	59461	59472	59483	59494	59506	59517	59528	59539
394	59550	59561	59572	59583	59594	59605	59616	59627	59638	59649
395	59660	59671	59682	59693	59704	59715	59726	59737	59748	59759
396	59770	59781	59792	59803	59814	59825	59836	59847	59858	59869
397	59879	59890	59901	59912	59923	59934	59945	59956	59967	59977
398	59988	59999	60010	60021	60032	60043	60054	60065	60076	60087
399	60097	60108	60119	60130	60141	60152	60163	60173	60184	60195
No	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No 4000— 4090.		Log 60206— 60275								
No.	0	1	2	3	4	5	6	7	8	9
400	60206	60217	60228	60239	60249	60260	60271	60282	60293	60304
401	60314	60325	60336	60347	60358	60369	60379	60390	60401	60412
402	60423	60433	60444	60455	60466	60477	60487	60498	60509	60520
403	60531	60541	60552	60563	60574	60584	60595	60606	60617	60627
404	60638	60649	60660	60670	60681	60692	60703	60714	60724	60735
405	60746	60756	60767	60778	60788	60799	60810	60821	60831	60842
406	60853	60863	60874	60885	60895	60906	60917	60927	60938	60949
407	60959	60970	60981	60991	61002	61013	61023	61034	61045	61055
408	61066	61077	61087	61098	61109	61119	61130	61140	61151	61162
409	61172	61183	61194	61204	61215	61225	61236	61247	61257	61268
410	61277	61289	61300	61310	61321	61331	61342	61352	61363	61374
411	61384	61395	61406	61416	61426	61437	61448	61458	61469	61479
412	61490	61500	61511	61521	61532	61542	61553	61563	61574	61584
413	61595	61606	61616	61627	61637	61648	61658	61669	61679	61690
414	61700	61711	61721	61731	61742	61752	61763	61773	61784	61794
415	61805	61815	61826	61836	61847	61857	61868	61878	61888	61899
416	61909	61920	61930	61941	61951	61962	61972	61982	61993	62003
417	62014	62024	62034	62045	62055	62066	62076	62086	62097	62107
418	62118	62128	62138	62149	62159	62170	62180	62190	62201	62211
419	62221	62232	62242	62252	62263	62273	62284	62294	62304	62315
420	62325	62335	62346	62356	62366	62377	62387	62397	62408	62418
421	62428	62439	62449	62459	62469	62480	62490	62500	62511	62521
422	62531	62542	62552	62562	62572	62583	62593	62603	62614	62624
423	62634	62644	62655	62665	62675	62685	62696	62706	62716	62726
424	62737	62747	62757	62767	62778	62788	62798	62808	62818	62829
425	62839	62849	62859	62870	62880	62890	62900	62910	62921	62931
426	62941	62951	62961	62972	62982	62992	63002	63012	63022	63033
427	63043	63053	63063	63073	63083	63094	63104	63114	63124	63134
428	63144	63155	63165	63175	63185	63195	63205	63215	63225	63236
429	63246	63256	63266	63276	63286	63296	63307	63317	63327	63337
430	63347	63357	63367	63377	63387	63397	63407	63417	63428	63438
431	63448	63458	63468	63478	63488	63498	63508	63518	63528	63538
432	63548	63558	63568	63578	63588	63598	63609	63619	63629	63639
433	63649	63659	63669	63679	63689	63699	63709	63719	63729	63739
434	63749	63759	63769	63779	63789	63799	63809	63819	63829	63839
435	63849	63859	63869	63879	63889	63899	63909	63919	63929	63939
436	63949	63959	63969	63979	63988	63998	64008	64018	64028	64038
437	64048	64058	64068	64078	64088	64098	64108	64118	64128	64137
438	64147	64157	64167	64177	64187	64197	64207	64217	64227	64237
439	64246	64256	64266	64276	64286	64296	64306	64316	64326	64336
440	64345	64355	64365	64375	64385	64395	64404	64414	64424	64434
441	64444	64454	64464	64474	64483	64493	64503	64513	64523	64532
442	64542	64552	64562	64572	64582	64591	64601	64611	64621	64631
443	64640	64650	64660	64670	64680	64689	64699	64709	64719	64729
444	64738	64748	64758	64768	64777	64787	64797	64807	64816	64826
445	64836	64846	64856	64865	64875	64885	64895	64905	64914	64924
446	64933	64943	64953	64963	64972	64982	64992	65002	65011	65021
447	65031	65040	65050	65060	65070	65079	65089	65099	65108	65118
448	65128	65137	65147	65157	65167	65176	65186	65196	65205	65215
449	65225	65234	65244	65254	65263	65273	65283	65292	65302	65312
450	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408
451	65418	65427	65437	65447	65456	65466	65475	65485	65495	65504
452	65514	65523	65533	65543	65552	65562	65571	65581	65591	65600
453	65610	65619	65629	65639	65648	65658	65667	65677	65686	65696
454	65706	65715	65725	65734	65744	65753	65763	65772	65782	65792
455	65801	65811	65820	65830	65839	65849	65858	65868	65877	65887
456	65896	65906	65916	65925	65935	65944	65954	65963	65973	65982
457	65992	66001	66011	66020	66030	66039	66049	66058	66068	66077
458	66087	66096	66106	66115	66124	66134	66143	66153	66162	66172
459	66181	66191	66200	66210	66219	66229	66238	66247	66257	66266
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 5200-----5800.					Log. 71600-----76					
No.	0	1	2	3	4	5	6	7	8	
520	71600	71609	71617	71625	71634	71642	71650	71659	71667	7
521	71631	71692	71700	71709	71717	71725	71734	71742	71750	7
522	71767	71775	71784	71792	71800	71809	71817	71825	71834	7
523	71850	71858	71867	71875	71883	71892	71900	71908	71917	7
524	71933	71941	71950	71958	71966	71975	71983	71991	71999	7
525	72016	72024	72032	72041	72049	72057	72066	72074	72082	7
526	72099	72107	72115	72123	72132	72140	72148	72156	72165	7
527	72181	72189	72198	72206	72214	72222	72230	72239	72247	7
528	72263	72272	72280	72288	72296	72304	72313	72321	72329	7
529	72346	72354	72362	72370	72378	72387	72395	72403	72411	7
530	72423	72436	72444	72452	72460	72469	72477	72485	72493	7
531	72509	72518	72526	72534	72542	72550	72558	72567	72575	7
532	72591	72599	72607	72616	72624	72632	72640	72648	72656	7
533	72673	72681	72689	72697	72705	72713	72722	72730	72738	7
534	72754	72762	72770	72779	72787	72795	72803	72811	72819	7
535	72835	72843	72852	72860	72868	72876	72884	72892	72900	7
536	72916	72925	72933	72941	72949	72957	72965	72973	72981	7
537	72997	73006	73014	73022	73030	73038	73046	73054	73062	7
538	73078	73086	73094	73102	73111	73119	73127	73135	73143	7
539	73159	73167	73175	73183	73191	73199	73207	73215	73223	7
540	73239	73247	73255	73263	73272	73280	73288	73296	73304	7
541	73320	73328	73336	73344	73352	73360	73368	73376	73384	7
542	73400	73408	73416	73424	73432	73440	73448	73456	73464	7
543	73480	73488	73496	73504	73512	73520	73528	73536	73544	7
544	73560	73568	73576	73584	73592	73600	73608	73616	73624	7
545	73640	73648	73656	73664	73672	73679	73687	73695	73703	7
546	73719	73727	73735	73743	73751	73759	73767	73775	73783	7
547	73799	73807	73815	73823	73830	73838	73846	73854	73862	7
548	73878	73886	73894	73902	73910	73918	73926	73933	73941	7
549	73957	73965	73973	73981	73989	73997	74005	74013	74020	7
550	74036	74044	74052	74060	74068	74076	74084	74092	74099	7
551	74115	74123	74131	74139	74147	74155	74162	74170	74178	7
552	74194	74202	74210	74218	74225	74233	74241	74249	74257	7
553	74273	74280	74288	74296	74304	74312	74320	74327	74335	7
554	74351	74359	74367	74374	74382	74390	74398	74406	74414	7
555	74429	74437	74445	74453	74461	74468	74476	74484	74492	7
556	74507	74515	74523	74531	74539	74547	74554	74562	74570	7
557	74586	74593	74601	74609	74617	74624	74632	74640	74648	7
558	74663	74671	74679	74687	74695	74702	74710	74718	74726	7
559	74741	74749	74757	74764	74772	74780	74788	74796	74803	7
560	74819	74827	74834	74842	74850	74858	74865	74873	74881	7
561	74896	74904	74912	74920	74927	74935	74943	74950	74958	7
562	74974	74981	74989	74997	75005	75012	75020	75028	75035	7
563	75051	75059	75066	75074	75082	75089	75097	75105	75113	7
564	75123	75136	75143	75151	75159	75166	75174	75182	75189	7
565	75205	75213	75220	75228	75236	75243	75251	75259	75266	7
566	75282	75289	75297	75305	75312	75320	75328	75335	75343	7
567	75358	75366	75374	75381	75389	75397	75404	75412	75420	7
568	75435	75442	75450	75458	75465	75473	75481	75488	75496	7
569	75511	75519	75526	75534	75542	75549	75557	75565	75572	7
570	75587	75595	75603	75610	75618	75626	75633	75641	75648	7
571	75664	75671	75679	75686	75694	75702	75709	75717	75724	7
572	75740	75747	75755	75762	75770	75778	75785	75793	75800	7
573	75815	75823	75831	75838	75846	75853	75861	75868	75876	7
574	75891	75899	75906	75914	75921	75929	75937	75944	75952	7
575	75967	75974	75982	75989	75997	76005	76012	76020	76027	7
576	76042	76050	76057	76065	76072	76080	76087	76095	76103	7
577	76118	76125	76133	76140	76148	76155	76163	76170	76178	7
578	76193	76200	76208	76215	76223	76230	76238	76245	76253	7
579	76268	76275	76283	76290	76298	76305	76313	76320	76328	7
No.	0	1	2	3	4	5	6	7	8	

TABLE XXVI

177

LOGARITHMS OF NUMBERS.

No. 5500—6400.				Log 76313—80619.						
No.	0	1	2	3	4	5	6	7	8	9
580	76314	76320	76327	76333	76339	76345	76351	76357	76363	76369
581	76418	76425	76432	76438	76444	76450	76456	76462	76468	76474
582	76572	76579	76585	76591	76597	76603	76609	76615	76621	76627
583	76634	76640	76646	76652	76658	76664	76670	76676	76682	76688
584	76792	76798	76804	76810	76816	76822	76828	76834	76840	76846
585	76950	76956	76962	76968	76974	76980	76986	76992	76998	77004
586	77108	77114	77120	77126	77132	77138	77144	77150	77156	77162
587	77266	77272	77278	77284	77290	77296	77302	77308	77314	77320
588	77424	77430	77436	77442	77448	77454	77460	77466	77472	77478
589	77582	77588	77594	77600	77606	77612	77618	77624	77630	77636
590	77740	77746	77752	77758	77764	77770	77776	77782	77788	77794
591	77908	77914	77920	77926	77932	77938	77944	77950	77956	77962
592	78076	78082	78088	78094	78100	78106	78112	78118	78124	78130
593	78244	78250	78256	78262	78268	78274	78280	78286	78292	78298
594	78402	78408	78414	78420	78426	78432	78438	78444	78450	78456
595	78560	78566	78572	78578	78584	78590	78596	78602	78608	78614
596	78728	78734	78740	78746	78752	78758	78764	78770	78776	78782
597	78896	78902	78908	78914	78920	78926	78932	78938	78944	78950
598	79064	79070	79076	79082	79088	79094	79100	79106	79112	79118
599	79222	79228	79234	79240	79246	79252	79258	79264	79270	79276
600	79380	79386	79392	79398	79404	79410	79416	79422	79428	79434
601	79548	79554	79560	79566	79572	79578	79584	79590	79596	79602
602	79716	79722	79728	79734	79740	79746	79752	79758	79764	79770
603	79884	79890	79896	79902	79908	79914	79920	79926	79932	79938
604	80052	80058	80064	80070	80076	80082	80088	80094	80100	80106
605	80220	80226	80232	80238	80244	80250	80256	80262	80268	80274
606	80392	80398	80404	80410	80416	80422	80428	80434	80440	80446
607	80568	80574	80580	80586	80592	80598	80604	80610	80616	80622
608	80744	80750	80756	80762	80768	80774	80780	80786	80792	80798
609	80924	80930	80936	80942	80948	80954	80960	80966	80972	80978
610	81104	81110	81116	81122	81128	81134	81140	81146	81152	81158
611	81288	81294	81300	81306	81312	81318	81324	81330	81336	81342
612	81472	81478	81484	81490	81496	81502	81508	81514	81520	81526
613	81660	81666	81672	81678	81684	81690	81696	81702	81708	81714
614	81852	81858	81864	81870	81876	81882	81888	81894	81900	81906
615	82048	82054	82060	82066	82072	82078	82084	82090	82096	82102
616	82244	82250	82256	82262	82268	82274	82280	82286	82292	82298
617	82440	82446	82452	82458	82464	82470	82476	82482	82488	82494
618	82600	82606	82612	82618	82624	82630	82636	82642	82648	82654
619	82768	82774	82780	82786	82792	82798	82804	82810	82816	82822
620	82940	82946	82952	82958	82964	82970	82976	82982	82988	82994
621	83108	83114	83120	83126	83132	83138	83144	83150	83156	83162
622	83280	83286	83292	83298	83304	83310	83316	83322	83328	83334
623	83456	83462	83468	83474	83480	83486	83492	83498	83504	83510
624	83640	83646	83652	83658	83664	83670	83676	83682	83688	83694
625	83808	83814	83820	83826	83832	83838	83844	83850	83856	83862
626	83992	83998	84004	84010	84016	84022	84028	84034	84040	84046
627	84184	84190	84196	84202	84208	84214	84220	84226	84232	84238
628	84384	84390	84396	84402	84408	84414	84420	84426	84432	84438
629	84592	84598	84604	84610	84616	84622	84628	84634	84640	84646
630	84760	84766	84772	84778	84784	84790	84796	84802	84808	84814
631	84944	84950	84956	84962	84968	84974	84980	84986	84992	84998
632	85120	85126	85132	85138	85144	85150	85156	85162	85168	85174
633	85304	85310	85316	85322	85328	85334	85340	85346	85352	85358
634	85496	85502	85508	85514	85520	85526	85532	85538	85544	85550
635	85692	85698	85704	85710	85716	85722	85728	85734	85740	85746
636	85888	85894	85900	85906	85912	85918	85924	85930	85936	85942
637	86084	86090	86096	86102	86108	86114	86120	86126	86132	86138
638	86280	86286	86292	86298	86304	86310	86316	86322	86328	86334
639	86488	86494	86500	86506	86512	86518	86524	86530	86536	86542
640	86696	86702	86708	86714	86720	86726	86732	86738	86744	86750
641	86892	86898	86904	86910	86916	86922	86928	86934	86940	86946
642	87088	87094	87100	87106	87112	87118	87124	87130	87136	87142
643	87284	87290	87296	87302	87308	87314	87320	87326	87332	87338
644	87480	87486	87492	87498	87504	87510	87516	87522	87528	87534
645	87680	87686	87692	87698	87704	87710	87716	87722	87728	87734
646	87840	87846	87852	87858	87864	87870	87876	87882	87888	87894
647	88000	88006	88012	88018	88024	88030	88036	88042	88048	88054
648	88168	88174	88180	88186	88192	88198	88204	88210	88216	88222
649	88344	88350	88356	88362	88368	88374	88380	88386	88392	88398
650	88512	88518	88524	88530	88536	88542	88548	88554	88560	88566
651	88720	88726	88732	88738	88744	88750	88756	88762	88768	88774
652	88904	88910	88916	88922	88928	88934	88940	88946	88952	88958
653	89088	89094	89100	89106	89112	89118	89124	89130	89136	89142
654	89296	89302	89308	89314	89320	89326	89332	89338	89344	89350
655	89480	89486	89492	89498	89504	89510	89516	89522	89528	89534
656	89680	89686	89692	89698	89704	89710	89716	89722	89728	89734
657	89840	89846	89852	89858	89864	89870	89876	89882	89888	89894
658	90000	90006	90012	90018	90024	90030	90036	90042	90048	90054
659	90168	90174	90180	90186	90192	90198	90204	90210	90216	90222
660	90344	90350	90356	90362	90368	90374	90380	90386	90392	90398
661	90512	90518	90524	90530	90536	90542	90548	90554	90560	90566
662	90720	90726	90732	90738	90744	90750	90756	90762	90768	90774
663	90904	90910	90916	90922	90928	90934	90940	90946	90952	90958
664	91088	91094	91100	91106	91112	91118	91124	91130	91136	91142
665	91296	91302	91308	91314	91320	91326	91332	91338	91344	91350
666	91480	91486	91492	91498	91504	91510	91516	91522	91528	91534
667	91680	91686	91692	91698	91704	91710	91716	91722	91728	91734
668	91840	91846	91852	91858	91864	91870	91876	91882	91888	91894
669	92000	92006	92012	92018	92024	92030	92036	92042	92048	92054
670	92168	92174	92180	92186	92192	92198	92204	92210	92216	92222
671	92344	92350	92356	92362	92368	92374	92380	92386	92392	92398
672	92512	92518	92524	92530	92536	92542	92548	92554	92560	92566
673	92720	92726	92732	92738	92744	92750	92756	92762	92768	92774
674	92904	92910	92916	92922	92928	92934	92940	92946	92952	92958
675	93088	93094	93100	93106	93112	93118	93124	93130	93136	93142
676	93296	93302	93308	93314	93320	93326	93332	93338	93344	93350
677	93480	93486	93492	93498	93504	93510	93516	93522	93528	93534
678	93680	93686	93692	93698	93704	93710	93716	93722	93728	93734
679	93840	93846	93852	93858	93864	93870	93876	93882	93888	93894
680	94000	94006	94012	94018	94024	94030	94036	94042	94048	94054
681	94168	94174	94180	94186	94192	94198	94204	94210	94216	94222
682	94344	94350	94356	94362	94368	94374	94380	94386	94392	94398
683	94512	94518	94524	94530	94536	94542	94548	94554	94560	94566
684	94720	94726	94732	94738	94744	94750	94756	94762	94768	94774
685	94904	94910	94916	94922	94928	94934	94940	94946	94952	94958
686	95088	95094	95100	95106	95112	95118				

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 6400—7000.						Log. 80618—84510.					
No.	0	1	2	3	4	5	6	7	8	9	
640	80618	80625	80632	80638	80645	80652	80659	80665	80672	80679	
641	80686	80693	80699	80706	80713	80720	80726	80733	80740	80747	
642	80754	80760	80767	80774	80781	80787	80794	80801	80808	80814	
643	80821	80828	80835	80841	80848	80855	80862	80868	80875	80882	
644	80889	80895	80902	80909	80916	80922	80929	80936	80943	80949	
645	80956	80963	80969	80976	80983	80990	80996	81003	81010	81017	
646	81023	81030	81037	81043	81050	81057	81064	81070	81077	81084	
647	81090	81097	81104	81111	81117	81124	81131	81137	81144	81151	
648	81158	81164	81171	81178	81184	81191	81198	81204	81211	81218	
649	81224	81231	81238	81245	81251	81258	81265	81271	81278	81285	
650	81291	81298	81305	81311	81318	81325	81331	81338	81345	81351	
651	81358	81365	81371	81378	81385	81391	81398	81405	81411	81418	
652	81425	81431	81438	81445	81451	81458	81465	81471	81478	81485	
653	81491	81498	81505	81511	81518	81525	81531	81538	81544	81551	
654	81558	81564	81571	81578	81584	81591	81598	81604	81611	81617	
655	81624	81631	81637	81644	81651	81657	81664	81671	81677	81684	
656	81690	81697	81704	81710	81717	81723	81730	81737	81743	81750	
657	81757	81763	81770	81776	81783	81790	81796	81803	81809	81816	
658	81823	81829	81836	81842	81849	81856	81862	81869	81875	81882	
659	81889	81895	81902	81908	81915	81921	81928	81935	81941	81948	
660	81954	81961	81968	81974	81981	81987	81994	82000	82007	82014	
661	82020	82027	82033	82040	82046	82053	82060	82066	82073	82079	
662	82086	82092	82099	82105	82112	82119	82125	82132	82138	82145	
663	82151	82158	82164	82171	82178	82184	82191	82197	82204	82210	
664	82217	82223	82230	82236	82243	82249	82256	82263	82269	82276	
665	82282	82289	82295	82302	82308	82315	82321	82328	82334	82341	
666	82347	82354	82360	82367	82373	82380	82387	82393	82400	82406	
667	82413	82419	82426	82432	82439	82445	82452	82458	82465	82471	
668	82478	82484	82491	82497	82504	82510	82517	82523	82530	82536	
669	82543	82549	82556	82562	82569	82575	82582	82588	82595	82601	
670	82607	82614	82620	82627	82633	82640	82646	82653	82659	82666	
671	82672	82679	82685	82692	82698	82705	82711	82718	82724	82730	
672	82737	82743	82750	82756	82763	82769	82776	82782	82789	82795	
673	82802	82808	82814	82821	82827	82834	82840	82847	82853	82860	
674	82866	82872	82879	82885	82892	82898	82905	82911	82918	82924	
675	82930	82937	82943	82950	82956	82963	82969	82975	82982	82988	
676	82995	83001	83008	83014	83020	83027	83033	83040	83046	83052	
677	83059	83065	83072	83078	83085	83091	83097	83104	83110	83117	
678	83123	83129	83136	83142	83149	83155	83161	83168	83174	83181	
679	83187	83193	83200	83206	83213	83219	83225	83232	83238	83245	
680	83251	83257	83264	83270	83276	83283	83289	83296	83302	83308	
681	83315	83321	83327	83334	83340	83347	83353	83359	83366	83372	
682	83378	83385	83391	83398	83404	83410	83417	83423	83429	83436	
683	83442	83448	83455	83461	83467	83474	83480	83487	83493	83499	
684	83506	83512	83518	83525	83531	83537	83544	83550	83556	83563	
685	83569	83575	83582	83588	83594	83601	83607	83613	83620	83626	
686	83632	83639	83645	83651	83658	83664	83670	83677	83683	83689	
687	83696	83702	83708	83715	83721	83727	83734	83740	83746	83753	
688	83759	83765	83771	83778	83784	83790	83797	83803	83809	83816	
689	83822	83828	83835	83841	83847	83853	83860	83866	83872	83879	
690	83885	83891	83897	83904	83910	83916	83923	83929	83935	83942	
691	83948	83954	83960	83967	83973	83979	83985	83992	83998	84004	
692	84011	84017	84023	84029	84036	84042	84048	84055	84061	84067	
693	84073	84080	84086	84092	84098	84105	84111	84117	84123	84130	
694	84136	84142	84148	84155	84161	84167	84173	84180	84186	84192	
695	84198	84205	84211	84217	84223	84230	84236	84242	84248	84255	
696	84261	84267	84273	84280	84286	84292	84298	84305	84311	84317	
697	84323	84330	84336	84342	84348	84354	84361	84367	84373	84379	
698	84386	84392	84398	84404	84410	84417	84423	84429	84435	84442	
699	84448	84454	84460	84466	84473	84479	84485	84491	84497	84504	
No.	0	1	2	3	4	5	6	7	8	9	

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 7000—7500.

Log. 84510—88001.

No.	0	1	2	3	4	5	6	7	8	9
700	84510	84516	84522	84528	84534	84541	84547	84553	84559	84565
701	84572	84578	84584	84590	84597	84603	84609	84615	84621	84628
702	84634	84640	84646	84652	84658	84665	84671	84677	84683	84689
703	84696	84702	84708	84714	84720	84726	84733	84739	84745	84751
704	84757	84763	84770	84776	84782	84788	84794	84800	84807	84813
705	84819	84825	84831	84837	84844	84850	84856	84862	84868	84874
706	84880	84887	84893	84899	84905	84911	84917	84924	84930	84936
707	84942	84948	84954	84960	84967	84973	84979	84985	84991	84997
708	85003	85009	85016	85022	85028	85035	85041	85047	85053	85059
709	85065	85071	85077	85083	85089	85095	85101	85107	85114	85120
710	85126	85132	85138	85144	85150	85156	85162	85169	85175	85181
711	85187	85193	85199	85205	85211	85217	85224	85230	85236	85242
712	85248	85254	85260	85266	85272	85278	85285	85291	85297	85303
713	85309	85315	85321	85327	85333	85339	85345	85352	85358	85364
714	85370	85376	85382	85388	85394	85400	85406	85412	85418	85425
715	85431	85437	85443	85449	85455	85461	85467	85473	85479	85485
716	85491	85497	85503	85509	85515	85521	85527	85533	85539	85545
717	85551	85557	85563	85569	85575	85581	85587	85593	85599	85605
718	85611	85617	85623	85629	85635	85641	85647	85653	85659	85665
719	85671	85677	85683	85689	85695	85701	85707	85713	85719	85725
720	85731	85737	85743	85749	85755	85761	85767	85773	85779	85785
721	85791	85797	85803	85809	85815	85821	85827	85833	85839	85845
722	85851	85857	85863	85869	85875	85881	85887	85893	85899	85905
723	85911	85917	85923	85929	85935	85941	85947	85953	85959	85965
724	85971	85977	85983	85989	85995	86001	86007	86013	86019	86025
725	86031	86037	86043	86049	86055	86061	86067	86073	86079	86085
726	86091	86097	86103	86109	86115	86121	86127	86133	86139	86145
727	86151	86157	86163	86169	86175	86181	86187	86193	86199	86205
728	86211	86217	86223	86229	86235	86241	86247	86253	86259	86265
729	86271	86277	86283	86289	86295	86301	86307	86313	86319	86325
730	86331	86337	86343	86349	86355	86361	86367	86373	86379	86385
731	86391	86397	86403	86409	86415	86421	86427	86433	86439	86445
732	86451	86457	86463	86469	86475	86481	86487	86493	86499	86505
733	86511	86517	86523	86529	86535	86541	86547	86553	86559	86565
734	86571	86577	86583	86589	86595	86601	86607	86613	86619	86625
735	86631	86637	86643	86649	86655	86661	86667	86673	86679	86685
736	86691	86697	86703	86709	86715	86721	86727	86733	86739	86745
737	86751	86757	86763	86769	86775	86781	86787	86793	86799	86805
738	86811	86817	86823	86829	86835	86841	86847	86853	86859	86865
739	86871	86877	86883	86889	86895	86901	86907	86913	86919	86925
740	86931	86937	86943	86949	86955	86961	86967	86973	86979	86985
741	86991	86997	87003	87009	87015	87021	87027	87033	87039	87045
742	87051	87057	87063	87069	87075	87081	87087	87093	87099	87105
743	87111	87117	87123	87129	87135	87141	87147	87153	87159	87165
744	87171	87177	87183	87189	87195	87201	87207	87213	87219	87225
745	87231	87237	87243	87249	87255	87261	87267	87273	87279	87285
746	87291	87297	87303	87309	87315	87321	87327	87333	87339	87345
747	87351	87357	87363	87369	87375	87381	87387	87393	87399	87405
748	87411	87417	87423	87429	87435	87441	87447	87453	87459	87465
749	87471	87477	87483	87489	87495	87501	87507	87513	87519	87525
750	87531	87537	87543	87549	87555	87561	87567	87573	87579	87585
751	87591	87597	87603	87609	87615	87621	87627	87633	87639	87645
752	87651	87657	87663	87669	87675	87681	87687	87693	87699	87705
753	87711	87717	87723	87729	87735	87741	87747	87753	87759	87765
754	87771	87777	87783	87789	87795	87801	87807	87813	87819	87825
755	87831	87837	87843	87849	87855	87861	87867	87873	87879	87885
756	87891	87897	87903	87909	87915	87921	87927	87933	87939	87945
757	87951	87957	87963	87969	87975	87981	87987	87993	87999	88005
758	88011	88017	88023	88029	88035	88041	88047	88053	88059	88065
759	88071	88077	88083	88089	88095	88101	88107	88113	88119	88125

TABLE XXVI.
LOGARITHMS OF NUMBERS.

No. 7600—8200.					Log. 88081—91381.						
No.	0	1	2	3	4	5	6	7	8	9	
760	88081	88097	88113	88129	88145	88161	88177	88193	88209	88225	
761	88138	88154	88170	88186	88202	88218	88234	88250	88266	88282	
762	88195	88211	88227	88243	88259	88275	88291	88307	88323	88339	
763	88252	88268	88284	88300	88316	88332	88348	88364	88380	88396	
764	88309	88325	88341	88357	88373	88389	88405	88421	88437	88453	
765	88365	88381	88397	88413	88429	88445	88461	88477	88493	88509	
766	88423	88439	88455	88471	88487	88503	88519	88535	88551	88567	
767	88480	88496	88512	88528	88544	88560	88576	88592	88608	88624	
768	88536	88552	88568	88584	88600	88616	88632	88648	88664	88680	
769	88593	88609	88625	88641	88657	88673	88689	88705	88721	88737	
770	88649	88665	88681	88697	88713	88729	88745	88761	88777	88793	
771	88705	88721	88737	88753	88769	88785	88801	88817	88833	88849	
772	88762	88778	88794	88810	88826	88842	88858	88874	88890	88906	
773	88818	88834	88850	88866	88882	88898	88914	88930	88946	88962	
774	88874	88890	88906	88922	88938	88954	88970	88986	88992	89008	
775	88930	88946	88962	88978	88994	89010	89026	89042	89058	89074	
776	88986	88992	89008	89024	89040	89056	89072	89088	89104	89120	
777	89042	89058	89074	89090	89106	89122	89138	89154	89170	89186	
778	89098	89114	89130	89146	89162	89178	89194	89210	89226	89242	
779	89154	89170	89186	89202	89218	89234	89250	89266	89282	89298	
780	89209	89225	89241	89257	89273	89289	89305	89321	89337	89353	
781	89265	89281	89297	89313	89329	89345	89361	89377	89393	89409	
782	89321	89337	89353	89369	89385	89401	89417	89433	89449	89465	
783	89376	89392	89408	89424	89440	89456	89472	89488	89504	89520	
784	89432	89448	89464	89480	89496	89512	89528	89544	89560	89576	
785	89487	89503	89519	89535	89551	89567	89583	89599	89615	89631	
786	89542	89558	89574	89590	89606	89622	89638	89654	89670	89686	
787	89597	89613	89629	89645	89661	89677	89693	89709	89725	89741	
788	89653	89669	89685	89701	89717	89733	89749	89765	89781	89797	
789	89708	89724	89740	89756	89772	89788	89804	89820	89836	89852	
790	89763	89779	89795	89811	89827	89843	89859	89875	89891	89907	
791	89818	89834	89850	89866	89882	89898	89914	89930	89946	89962	
792	89873	89889	89905	89921	89937	89953	89969	89985	90001	90017	
793	89927	89943	89959	89975	89991	90007	90023	90039	90055	90071	
794	89982	90000	90016	90032	90048	90064	90080	90096	90112	90128	
795	90037	90053	90069	90085	90101	90117	90133	90149	90165	90181	
796	90091	90107	90123	90139	90155	90171	90187	90203	90219	90235	
797	90146	90162	90178	90194	90210	90226	90242	90258	90274	90290	
798	90200	90216	90232	90248	90264	90280	90296	90312	90328	90344	
799	90255	90271	90287	90303	90319	90335	90351	90367	90383	90399	
800	90309	90325	90341	90357	90373	90389	90405	90421	90437	90453	
801	90363	90379	90395	90411	90427	90443	90459	90475	90491	90507	
802	90417	90433	90449	90465	90481	90497	90513	90529	90545	90561	
803	90472	90488	90504	90520	90536	90552	90568	90584	90600	90616	
804	90526	90542	90558	90574	90590	90606	90622	90638	90654	90670	
805	90580	90596	90612	90628	90644	90660	90676	90692	90708	90724	
806	90634	90650	90666	90682	90698	90714	90730	90746	90762	90778	
807	90687	90703	90719	90735	90751	90767	90783	90799	90815	90831	
808	90741	90757	90773	90789	90805	90821	90837	90853	90869	90885	
809	90795	90811	90827	90843	90859	90875	90891	90907	90923	90939	
810	90849	90865	90881	90897	90913	90929	90945	90961	90977	90993	
811	90902	90918	90934	90950	90966	90982	90998	91014	91030	91046	
812	90956	90972	90988	91004	91020	91036	91052	91068	91084	91100	
813	91009	91025	91041	91057	91073	91089	91105	91121	91137	91153	
814	91062	91078	91094	91110	91126	91142	91158	91174	91190	91206	
815	91116	91132	91148	91164	91180	91196	91212	91228	91244	91260	
816	91169	91185	91201	91217	91233	91249	91265	91281	91297	91313	
817	91222	91238	91254	91270	91286	91302	91318	91334	91350	91366	
818	91275	91291	91307	91323	91339	91355	91371	91387	91403	91419	
819	91328	91344	91360	91376	91392	91408	91424	91440	91456	91472	
No.	0	1	2	3	4	5	6	7	8	9	

TABLE XXVI.

181

LOGARITHMS OF NUMBERS.

No. 820—900.

Log. 91301—94448.

n	0	1	2	3	4	5	6	7	8	9
820	91381	91387	91392	91397	91403	91408	91413	91418	91424	91429
821	91434	91440	91445	91450	91455	91461	91466	91471	91477	91482
822	91487	91492	91498	91503	91508	91514	91519	91524	91529	91535
823	91540	91545	91551	91556	91561	91566	91572	91577	91582	91587
824	91593	91598	91603	91609	91614	91619	91624	91630	91635	91640
825	91645	91651	91656	91661	91666	91672	91677	91682	91687	91693
826	91698	91703	91709	91714	91719	91724	91730	91735	91740	91745
827	91751	91756	91761	91766	91772	91777	91782	91787	91793	91798
828	91803	91808	91814	91819	91824	91829	91834	91840	91845	91850
829	91855	91861	91866	91871	91876	91882	91887	91892	91897	91903
830	91908	91913	91918	91924	91929	91934	91939	91944	91950	91955
831	91960	91965	91971	91976	91981	91986	91991	91997	92002	92007
832	92012	92018	92023	92028	92033	92038	92044	92049	92054	92059
833	92065	92070	92075	92080	92085	92091	92096	92101	92106	92111
834	92117	92122	92127	92132	92137	92143	92148	92153	92158	92163
835	92169	92174	92179	92184	92189	92195	92200	92205	92210	92215
836	92221	92226	92231	92236	92241	92247	92252	92257	92262	92267
837	92273	92278	92283	92288	92293	92298	92304	92309	92314	92319
838	92324	92330	92335	92340	92345	92350	92355	92361	92366	92371
839	92376	92381	92387	92392	92397	92402	92407	92412	92418	92423
840	92428	92433	92438	92443	92449	92454	92459	92464	92469	92474
841	92480	92485	92490	92495	92500	92506	92511	92516	92521	92526
842	92531	92536	92542	92547	92552	92557	92562	92567	92572	92578
843	92583	92588	92593	92598	92603	92609	92614	92619	92624	92629
844	92634	92639	92645	92650	92655	92660	92665	92670	92675	92681
845	92686	92691	92696	92701	92706	92711	92716	92722	92727	92732
846	92737	92742	92747	92752	92758	92763	92768	92773	92778	92783
847	92788	92793	92799	92804	92809	92814	92819	92824	92829	92834
848	92840	92845	92850	92855	92860	92865	92870	92875	92881	92886
849	92891	92896	92901	92906	92911	92916	92921	92927	92932	92937
850	92942	92947	92952	92957	92962	92967	92973	92978	92983	92988
851	92993	92998	93003	93008	93013	93018	93024	93029	93034	93039
852	93044	93049	93054	93059	93064	93069	93075	93080	93085	93090
853	93095	93100	93105	93110	93115	93120	93125	93131	93136	93141
854	93146	93151	93156	93161	93166	93171	93176	93181	93186	93192
855	93197	93202	93207	93212	93217	93222	93227	93232	93237	93242
856	93247	93252	93257	93263	93268	93273	93278	93283	93288	93293
857	93298	93303	93308	93313	93318	93323	93328	93334	93339	93344
858	93349	93354	93359	93364	93369	93374	93379	93384	93389	93394
859	93399	93404	93409	93414	93420	93425	93430	93435	93440	93445
860	93450	93455	93460	93465	93470	93475	93480	93485	93490	93495
861	93500	93505	93510	93515	93520	93525	93531	93536	93541	93546
862	93551	93556	93561	93566	93571	93576	93581	93586	93591	93596
863	93601	93606	93611	93616	93621	93626	93631	93636	93641	93646
864	93651	93656	93661	93666	93671	93676	93682	93687	93692	93697
865	93702	93707	93712	93717	93722	93727	93732	93737	93742	93747
866	93752	93757	93762	93767	93772	93777	93782	93787	93792	93797
867	93802	93807	93812	93817	93822	93827	93832	93837	93842	93847
868	93852	93857	93862	93867	93872	93877	93882	93887	93892	93897
869	93902	93907	93912	93917	93922	93927	93932	93937	93942	93947
870	93952	93957	93962	93967	93972	93977	93982	93987	93992	93997
871	94002	94007	94012	94017	94022	94027	94032	94037	94042	94047
872	94052	94057	94062	94067	94072	94077	94082	94087	94092	94096
873	94101	94106	94111	94116	94121	94126	94131	94136	94141	94146
874	94151	94156	94161	94166	94171	94176	94181	94186	94191	94196
875	94201	94206	94211	94216	94221	94226	94231	94236	94241	94245
876	94250	94255	94260	94265	94270	94275	94280	94285	94290	94295
877	94300	94305	94310	94315	94320	94325	94330	94335	94340	94345
878	94349	94354	94359	94364	94369	94374	94379	94384	94389	94394
879	94399	94404	94409	94414	94419	94424	94429	94433	94438	94443

No. 94449—97596.

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 8800—9400.				Log. 9448—97313.						
No.	0	1	2	3	4	5	6	7	8	9
880	94440	94453	94466	94479	94492	94505	94518	94531	94544	94557
881	94498	94503	94507	94512	94517	94522	94527	94532	94537	94542
882	94547	94552	94557	94562	94567	94571	94576	94581	94586	94591
883	94596	94601	94606	94611	94616	94621	94626	94630	94635	94640
884	94645	94650	94655	94660	94665	94670	94675	94680	94685	94689
885	94694	94699	94704	94709	94714	94719	94724	94729	94734	94738
886	94743	94748	94753	94758	94763	94768	94773	94778	94783	94787
887	94792	94797	94802	94807	94812	94817	94822	94827	94832	94836
888	94841	94846	94851	94856	94861	94866	94871	94876	94880	94885
889	94890	94895	4900	94905	94910	94915	94919	94924	94929	94934
890	94939	94944	94949	94954	94959	94963	94968	94973	94978	94983
891	94988	94993	94998	95002	95007	95012	95017	95022	95027	95032
892	95036	95041	95046	95051	95056	95061	95066	95071	95076	95080
893	95085	95090	95095	95100	95105	95109	95114	95119	95124	95129
894	95134	95139	95144	95148	95153	95158	95163	95168	95173	95177
895	95182	95187	95192	95197	95202	95207	95211	95216	95221	95226
896	95231	95236	95240	95245	95250	95255	95260	95265	95270	95274
897	95279	95284	95289	95294	95299	95303	95308	95313	95318	95323
898	95328	95332	95337	95342	95347	95352	95357	95361	95366	95371
899	95376	95381	95386	95390	95395	95400	95405	95410	95415	95419
900	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468
901	95472	95477	95482	95487	95492	95497	95501	95506	95511	95516
902	95521	95525	95530	95535	95540	95545	95550	95554	95559	95564
903	95569	95574	95578	95583	95588	95593	95598	95602	95607	95612
904	95617	95622	95626	95631	95636	95641	95646	95650	95655	95660
905	95665	95670	95674	95679	95684	95689	95694	95699	95703	95708
906	95713	95718	95722	95727	95732	95737	95742	95746	95751	95756
907	95761	95766	95770	95775	95780	95785	95789	95794	95799	95804
908	95809	95813	95818	95823	95828	95832	95837	95842	95847	95852
909	95856	95861	95866	95871	95875	95880	95885	95890	95895	95899
910	95904	95909	95914	95918	95923	95928	95933	95938	95942	95947
911	95952	95957	95961	95966	95971	95976	95980	95985	95990	95995
912	95999	96004	96009	96014	96019	96023	96028	96033	96038	96042
913	96047	96052	96057	96061	96066	96071	96076	96080	96085	96090
914	96095	96099	96104	96109	96114	96118	96123	96128	96133	96137
915	96142	96147	96152	96156	96161	96166	96171	96175	96180	96185
916	96190	96194	96199	96204	96209	96213	96218	96223	96227	96232
917	96237	96242	96246	96251	96256	96261	96265	96270	96275	96280
918	96284	96289	96294	96298	96303	96308	96313	96317	96322	96327
919	96332	96336	96341	96346	96350	96355	96360	96365	96369	96374
920	96379	96384	96388	96393	96398	96402	96407	96412	96417	96421
921	96426	96431	96435	96440	96445	96450	96454	96459	96464	96468
922	96473	96478	96483	96487	96492	96497	96501	96506	96511	96516
923	96520	96525	96530	96534	96539	96544	96548	96553	96558	96562
924	96567	96572	96577	96581	96586	96591	96595	96600	96605	96609
925	96614	96619	96624	96628	96633	96638	96642	96647	96652	96656
926	96661	96666	96670	96675	96680	96685	96689	96694	96699	96703
927	96708	96713	96717	96722	96727	96731	96736	96741	96745	96750
928	96755	96759	96764	96769	96774	96778	96783	96788	96792	96797
929	96802	96806	96811	96816	96820	96825	96830	96834	96839	96844
930	96848	96853	96858	96862	96867	96872	96876	96881	96886	96890
931	96895	96900	96904	96909	96914	96918	96923	96928	96932	96937
932	96942	96946	96951	96956	96960	96965	96970	96974	96979	96984
933	96988	96993	96997	97002	97007	97011	97016	97021	97025	97030
934	97035	97039	97044	97049	97053	97058	97063	97067	97072	97077
935	97081	97086	97090	97095	97100	97104	97109	97114	97118	97123
936	97128	97132	97137	97142	97146	97151	97155	97160	97165	97169
937	97174	97179	97183	97188	97192	97197	97202	97206	97211	97216
938	97220	97225	97230	97234	97239	97243	97248	97253	97257	97262
939	97267	97271	97276	97280	97285	97290	97294	97299	97304	97308
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

183

LOGARITHMS OF NUMBERS.

No. 9400—10000.					Log 97513—99996					
No.	0	1	2	3	4	5	6	7	8	9
940	97313	97317	97322	97327	97331	97336	97340	97345	97350	97354
941	97359	97364	97368	97373	97377	97382	97387	97391	97396	97400
942	97405	97410	97414	97419	97424	97428	97433	97437	97442	97447
943	97451	97456	97460	97465	97470	97474	97479	97483	97488	97493
944	97497	97502	97506	97511	97516	97520	97525	97529	97534	97539
945	97543	97548	97552	97557	97562	97566	97571	97575	97580	97585
946	97589	97594	97598	97603	97607	97612	97617	97621	97626	97630
947	97635	97640	97644	97649	97653	97658	97662	97667	97672	97676
948	97681	97685	97690	97694	97699	97704	97708	97713	97717	97722
949	97727	97731	97736	97740	97745	97749	97754	97759	97763	97768
950	97772	97777	97781	97786	97790	97795	97800	97804	97809	97813
951	97818	97823	97827	97832	97836	97841	97845	97850	97854	97859
952	97864	97868	97873	97877	97882	97886	97891	97896	97900	97905
953	97909	97914	97918	97923	97927	97932	97937	97941	97946	97950
954	97955	97959	97964	97968	97973	97978	97982	97987	97991	97996
955	98000	98005	98009	98014	98019	98023	98028	98032	98037	98041
956	98046	98050	98055	98059	98064	98068	98073	98077	98082	98087
957	98091	98096	98100	98105	98109	98114	98118	98123	98127	98132
958	98137	98141	98146	98150	98155	98159	98164	98168	98173	98177
959	98182	98186	98191	98195	98200	98204	98209	98214	98218	98223
960	98227	98232	98236	98241	98245	98250	98254	98259	98263	98268
961	98272	98277	98281	98286	98290	98295	98299	98304	98308	98313
962	98318	98322	98327	98331	98336	98340	98345	98349	98354	98358
963	98363	98367	98372	98376	98381	98385	98390	98394	98399	98403
964	98408	98412	98417	98421	98426	98430	98435	98439	98444	98448
965	98453	98457	98462	98466	98471	98475	98480	98484	98489	98493
966	98498	98502	98507	98511	98516	98520	98525	98529	98534	98538
967	98543	98547	98552	98556	98561	98565	98570	98574	98579	98583
968	98588	98592	98597	98601	98605	98610	98614	98619	98623	98628
969	98632	98637	98641	98646	98650	98655	98659	98664	98668	98673
970	98677	98682	98686	98691	98695	98700	98704	98709	98713	98717
971	98722	98726	98731	98735	98740	98744	98749	98753	98758	98762
972	98767	98771	98776	98780	98784	98789	98793	98798	98802	98807
973	98811	98816	98820	98825	98829	98834	98838	98843	98847	98851
974	98856	98860	98865	98869	98874	98878	98883	98887	98892	98896
975	98900	98905	98909	98914	98918	98923	98927	98932	98936	98941
976	98945	98949	98954	98958	98963	98967	98972	98976	98981	98985
977	98989	98994	98998	99003	99007	99012	99016	99021	99025	99029
978	99034	99038	99043	99047	99052	99056	99061	99065	99069	99074
979	99078	99083	99087	99092	99096	99100	99105	99109	99114	99118
980	99122	99127	99131	99136	99140	99145	99149	99154	99158	99162
981	99167	99171	99176	99180	99185	99189	99193	99198	99202	99207
982	99211	99216	99220	99224	99229	99233	99238	99242	99247	99251
983	99255	99260	99264	99269	99273	99277	99282	99286	99291	99295
984	99300	99304	99308	99313	99317	99322	99326	99330	99335	99339
985	99344	99348	99352	99357	99361	99366	99370	99374	99379	99383
986	99388	99392	99396	99401	99405	99410	99414	99419	99423	99427
987	99432	99436	99441	99445	99449	99454	99458	99463	99467	99471
988	99476	99480	99484	99489	99493	99498	99502	99506	99511	99515
989	99520	99524	99528	99533	99537	99542	99546	99550	99555	99559
990	99564	99568	99572	99577	99581	99585	99590	99594	99599	99603
991	99607	99612	99616	99621	99625	99629	99634	99638	99642	99647
992	99651	99656	99660	99664	99669	99673	99677	99682	99686	99691
993	99695	99699	99704	99708	99712	99717	99721	99726	99730	99734
994	99739	99743	99747	99752	99756	99760	99765	99769	99774	99778
995	99782	99787	99791	99795	99800	99804	99808	99813	99817	99822
996	99826	99830	99835	99839	99843	99848	99852	99857	99861	99865
997	99870	99874	99878	99883	99887	99891	99896	99900	99904	99909
998	99913	99917	99922	99926	99930	99935	99939	99944	99948	99952
999	99957	99961	99966	99970	99974	99978	99983	99987	99991	99996
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVII.

Log. Sines, Tangents and Secants.

0 Deg.

Degs. 179

M.	Hour	Min.	Hour	Min.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M.
0	12	0	0	0	Inf. Neg.	10 00000	Inf. Neg.	Infinite.	10 00000	Infinite	60
1	11	59	52	0	5.46373	00000	6 46373	13 53627	00000	13.53627	59
2		59	44	0	76476	00000	76476	23524	00000	23524	58
3		59	36	0	94085	00000	94085	05915	00000	05915	57
4		59	28	0	7 06579	00000	7 06579	12 93421	00000	12 93421	56
5	11	59	20	0	7 16270	00000	7.16270	12 83730	10 00000	12 83730	55
6		59	12	0	24188	00000	24188	75812	00000	75812	54
7		59	4	0	30882	00000	30882	69115	00000	69118	53
8		58	56	1	36682	00000	36682	63318	00000	63318	52
9		58	48	1	41797	00000	41797	58203	00000	58203	51
10	11	58	40	0	7.46373	00000	7 46373	12 53627	10 00000	12 53627	50
11		58	32	1	50512	00000	50512	49488	00000	49488	49
12		58	24	1	54291	00000	54291	45709	00000	45709	48
13		58	16	1	57767	00000	57767	42233	00000	42233	47
14		58	8	1	60985	00000	60985	39014	00000	39014	46
15	11	58	0	0	7 63922	00000	7.63922	12 3601	10 00000	12 36018	45
16		57	52	2	66784	00000	66785	33215	00000	33216	44
17		57	44	2	69417	9 99999	69418	30582	00001	30583	43
18		57	36	2	71940	99999	71900	28100	00001	28100	42
19		57	28	2	74248	99999	74248	25752	00001	25752	41
20	11	57	20	0	7.76476	9 99999	7 76476	12.23524	10.00001	12 23525	40
21		57	12	2	78594	99999	78595	21405	00001	21406	39
22		57	4	2	80615	99999	80615	19385	00001	19385	38
23		56	56	3	82545	99999	82546	17454	00001	17455	37
24		56	48	3	84393	99999	84394	15606	00001	15607	36
25	11	56	40	0	7.86166	9 99999	7.86167	12 13833	10.00001	12 13834	35
26		56	32	3	87870	99999	87871	12129	00001	12130	34
27		56	24	3	89509	99999	89510	10490	00001	10491	33
28		56	16	3	91038	99999	91039	08911	00001	08912	32
29		56	8	3	92612	99998	92613	07387	00002	07388	31
30	11	56	0	0	7.94084	9 99998	7 94086	12 05914	10 00002	12 05916	30
31		55	52	4	95508	99998	95510	04490	00002	04492	29
32		55	44	4	96887	99998	96889	03111	00002	03113	28
33		55	36	4	98223	99998	98225	01775	00002	01777	27
34		55	28	4	99520	99997	99522	00478	00002	00480	26
35	11	55	20	0	8.00779	9 99998	8 00781	11.99219	10 00002	11.99221	25
36		55	12	4	02002	99998	02004	97996	00002	97998	24
37		55	4	4	03192	99997	03194	96806	00003	96808	23
38		54	56	5	04350	99997	04353	95647	00003	95650	22
39		54	48	5	05478	99997	05481	94519	00003	94522	21
40	11	54	40	0	8.06578	9 99997	8.06581	11.93419	10 00003	11.93422	20
41		54	32	5	07650	99997	07653	92347	00003	92350	19
42		54	24	5	08696	99997	08700	91300	00003	91304	18
43		54	16	5	09718	99997	09722	90278	00003	90282	17
44		54	8	5	10717	99996	10720	89280	00004	89283	16
45	11	54	0	0	8.11693	9 99996	8.11696	11.88304	10.00004	11.88307	15
46		53	52	6	12647	99996	12651	87349	00004	87353	14
47		53	44	6	13581	99996	13585	86413	00004	86419	13
48		53	36	6	14495	99996	14500	85500	00004	85505	12
49		53	28	6	15391	99996	15395	84605	00004	84609	11
50	11	53	20	0	8.16268	9 99995	8.16273	11.83727	10 00006	11.83732	10
51		53	12	6	17128	99995	17133	82867	00005	82872	9
52		53	4	6	17971	99995	17976	82024	00005	82029	8
53		52	56	7	18798	99995	18804	81196	00005	81202	7
54		52	48	7	19610	99995	19616	80384	00005	80390	6
55	11	52	40	0	8.20407	9.99994	8.20413	11 79587	10 00006	11.79593	5
56		52	32	7	21189	99994	21195	78805	00006	78811	4
57		52	24	7	21958	99994	21964	78036	00006	78042	3
58		52	16	7	22713	99994	22720	77280	00006	77287	2
59		52	8	7	23462	99994	23468	76538	00006	76544	1
60		52	0	8	24192	99993	24192	75808	00007	75816	0

M. Hour. Min. Hour. Min. Co-sine. Sine. Co-tang. Tangent. Co-secant. Secant. M.

90 Degs.

Degs. 180

TABLE XXVII.

185

Log. Sines, Tangents and Secants.

1 Deg.

Degs. 178.

M	Hours.	m.	Hour.	m.	Sine.	Co-sine	Tangent.	Co-tang.	Secant	Co-secant	M							
0	11	52	0	0	8	24186	9	99993	8	24192	11	75808	10	00007	11	75814	60	
1		51	52		8	24903		99993	24910	75090		00007					59	
2		51	44		8	26609		99993		74384					74391		58	
3		51	36		8	26304		99993	26312	73688					73696		57	
4		51	28		8			99992	26996						73012		56	
5	11	51	20	0	8	27661	9	99992	8	27669	11	72331	10	00008	11	72339	55	
6		51	12		8	28324		99992	28332	71668		00008			71676		54	
7		51	4		8	28977				71014		00008			71023		53	
8		50	56		9	29621		99992	29629	70371					70379		52	
9		50	48		9	30255		99991	30263			00009			69745		51	
10	11	50	40	0	9	30879	9	99991	8	30888	11	69112	10	00009	11	69121	50	
11		50	32		9	31495			31505	68495		00009			68505		49	
12		50	24		9	32103		99990	32112	67888		00010			67897		48	
13		50	16		9	32702		99990	32711	67289		00010			67298		47	
14		50	8		9	33292		99990	33302	66698		00010			66708		46	
15	11	50	0	0	8	33875	9	99990	8	33886	11	66114	10	00010	11	66125	45	
16		49	52		10				34461	65539		00011			65550		44	
17		49	44		10	35018		99989	35029	64971		00011			64982		43	
18		49	36		10	35572		99989	35590	64410		00011			64422		42	
19		49	28		10	36131		99989		63857		00011			63869		41	
20	11	49	20	0	10		9	99988	8	36609	11	63311	10	00012	11	63322	40	
21		49	12		10	37217		99988	37229	62771					62783		39	
22		49	4		10	37750		99988		62238					62250		38	
23		48	56		11	38276		99987	38289	61711		00013			61724		37	
24		48	48		11	38796		99987	38809	61191		00013			61204		36	
25	11	48	40	0	11	39310	9	99987	8	39323	11	60677	10	00013	11	60690	35	
26		48	32		11	39818		99986	39832	60160		00014			60182			
27		48	24		11	40320		99986		59666					59680		33	
28		48	16		11	40816		99986		59170		00014					32	
29		48	8		11	41307		99985							58693		31	
30	11	48	0	0	12	8	41792	9	99985	8	41807	11	58193		11	58208	30	
31		47	52		12	42272		99985	42287						57720		29	
32		47	44		12	42746			42762	57238		00016			57254		28	
33		47	36		12	43216		99984	43232	56768		00016			56784		27	
34		47	28		12	43680		99984	43696	56304					56320		26	
35	11	47	20	0	12	8	44139		8	44156	11	55844	10	00017	11	55861	25	
36		47	12		12	44594				55389		00017			55406		24	
37		47	4		12	45044		99983	45061	54939		00017			54956		23	
38		46	56		13	45489			45507	54493		00018			54511		22	
39		46	48		13			99982	45948	54052		00018			54070		21	
40	11	46	40	0	13	8	46366	9	99982		11	53616	10	00018	11	53634	20	
41		46	32		13	46799		99981	46817	53183		00019			53201		19	
42		46	24		13			99981	47245	52756		00019			52774		18	
43		46	16		13	47650		99981		52331		00019			52350		17	
44		46	8		13	48069		99980		51911		00020			51931		16	
45	11	46	0	0	14	8	48485	9	99980	8	48505	11	51495	10	00020	11	51515	15
46		45	52		14	48896		99979		51083		00021						
47		45	44		14			99979	49325	50675					50696		13	
48		45	36		14				49729	50271		00021			50292		12	
49		45	28		14	50108		99978	50150	49870		00022			49892		11	
50	11	45	20	0	14	8	50604		8	50627	11	49473	10	00022	11	49496	10	
51		45	12		14	50897		99977	50920	49080		00023			49103			
52		45	4		14	51287		99977	51310			00023			48713		8	
53		44	56		15			99977	51696	48304		00023			48327		7	
54		44	48		15			99976	52079						47945		6	
55	11	44	40	0	15			9	99976	8	52459	11	47541	10	00024	11	47566	5
56		44	32		15				99975	52835		47165		00025		47190		4
57		44	24					99975	53208					00025		46817		
58		44	16		15	44		99974	53578	46422		00026			46448		2	
59		44	8		15	52	53919	99974	53945	46053		00026			46081		1	
60		44	0		15	0	54282	99974	54308	45692		00026			45712		0	

M.	Hours.	m.	Hours.	m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant	M.
----	--------	----	--------	----	----------	-------	----------	----------	-----------	--------	----

11 Degs.

2

Degs. 178.

TABLE XXVII.
Log. Sines, Tangents and Secants.

1 Degs.

Degs. 177.

M.	Hour A.M.	Hour P.M.	Sine	Co-sine	Tangent	Co-tang	Secant	Co-secant	M.
0	11 44 0	0 16 0	3.54282	9.99974	8.54308	11.45692	10.00026	11.45718	60
1	43 52	16 8	54642	99973	54669	45331	00027	45358	59
2	43 44	16 16	54999	99973	55027	44973	00027	45001	58
3	43 36	16 24	55354	99972	55382	44618	00028	44646	57
4	43 28	16 32	55705	99972	55734	44266	00028	44295	56
5	11 43 20	0 16 40	8.56054	9.99971	8.56083	11.43917	10.00029	11.43946	55
6	43 12	16 48	56400	99971	56429	43571	00029	43600	54
7	43 4	16 56	56743	99970	56773	43227	00030	43257	53
8	42 56	17 4	57034	99970	57114	42886	00030	42916	52
9	42 48	17 12	57421	99969	57452	42548	00031	42579	51
10	11 42 40	0 17 20	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	42 32	17 28	58089	99968	58121	41879	00032	41911	49
12	42 24	17 36	58419	99968	58451	41549	00032	41581	48
13	42 16	17 44	58747	99967	58779	41221	00033	41253	47
14	42 8	17 52	59072	99967	59105	40895	00033	40928	46
15	11 42 0	0 18 0	8.59395	9.99967	8.59428	11.40372	10.00033	11.40606	45
16	41 52	18 8	59715	99966	59749	40531	00034	40565	44
17	41 44	18 16	60033	99966	60068	39932	00034	39967	43
18	41 36	18 24	60349	99965	60384	39616	00035	39651	42
19	41 28	18 32	60662	99964	60698	39302	00036	39338	41
20	11 41 20	0 18 40	8.60973	9.99964	8.61009	11.38991	10.00036	11.39027	40
21	41 12	18 48	61282	99963	61319	38681	00037	38718	39
22	41 4	18 56	61589	99963	61626	38374	00037	38411	38
23	40 56	19 4	61894	99962	61931	38069	00038	38106	37
24	40 48	19 12	62196	99962	62234	37766	00038	37804	36
25	11 40 40	0 19 20	8.62497	9.99961	8.62535	11.37465	10.00039	11.37503	35
26	40 32	19 28	62795	99961	62834	37166	00039	37205	34
27	40 24	19 36	63091	99960	63131	36869	00040	36909	33
28	40 16	19 44	63385	99960	63426	36574	00040	36615	32
29	40 8	19 52	63678	99959	63718	36282	00041	36322	31
30	11 40 0	0 20 0	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	39 52	20 8	64256	99958	64298	35702	00042	35744	29
32	39 44	20 16	64543	99958	64586	35418	00042	35457	28
33	39 36	20 24	64827	99957	64870	35130	00043	35173	27
34	39 28	20 32	65110	99956	65154	34846	00044	34890	26
35	11 39 20	0 20 40	8.65391	9.99956	8.65436	11.34565	10.00044	11.34609	25
36	39 12	20 48	65670	99955	65715	34285	00045	34330	24
37	39 4	20 56	65947	99955	65993	34007	00045	34053	23
38	38 56	21 4	66223	99954	66269	33731	00046	33777	22
39	38 48	21 12	66497	99954	66543	33457	00046	33503	21
40	11 38 40	0 21 20	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	38 32	21 28	67039	99952	67087	32913	00047	32961	19
42	38 24	21 36	67308	99952	67356	32644	00048	32692	18
43	38 16	21 44	67575	99951	67624	32376	00049	32425	17
44	38 8	21 52	67841	99951	67890	32110	00049	32159	16
45	11 38 0	0 22 0	8.68104	9.99950	8.68154	11.31846	10.00050	11.31896	15
46	37 52	22 8	68367	99949	68417	31583	00051	31633	14
47	37 44	22 16	68627	99949	68678	31322	00051	31373	13
48	37 36	22 24	68886	99948	68938	31062	00052	31114	12
49	37 28	22 32	69144	99948	69196	30804	00052	30856	11
50	11 37 20	0 22 40	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	37 12	22 48	69654	99946	69707	30292	00054	30345	9
52	37 4	22 56	69907	99946	69962	30038	00054	30093	8
53	36 56	23 4	70159	99945	70214	29786	00055	29841	7
54	36 48	23 12	70409	99944	70465	29535	00055	29591	6
55	11 36 40	0 23 20	8.70658	9.99944	8.70714	11.29286	10.00056	11.29342	5
56	36 32	23 28	70905	99943	70962	29038	00057	29095	4
57	36 24	23 36	71151	99942	71208	28792	00058	28849	3
58	36 16	23 44	71396	99942	71453	28547	00058	28605	2
59	36 8	23 52	71640	99941	71697	28302	00059	28361	1
60	36 0	24 0	71880	99940	71940	28060	00060	28120	0

32 Degs.

Degs. 5.

TABLE XXVII.
Log. Sines, Tangents and Secants.

187

3 Degs.

Degs. 176

M	Hour	Min	Hour	Min	Sine	Co-sine	Tangent	Co-tang	Secant	Co-secant	M		
0	11	36	0	0	24	0	8 71880	9 99940	8 71940	11 28060	10 00060	11 28120	60
1		36	52	24	8		72120	99940	72181	27819	00060	27880	59
2		35	44	24	16		72359	99939	72420	27580	00061	27641	58
3		35	36	24	24		72597	99938	72659	27341	00062	27403	57
4		35	28	24	32		72834	99938	72896	27104	00062	27166	56
5	11	35	20	0	24	40	8 73069	9 99937	8 73132	11 26368	10 00063	11 26931	55
6		35	12	24	48		73303	99936	73366	26634	00064	26697	54
7		35	4	24	56		73535	99936	73600	26400	00064	26465	53
8		34	56	25	4		73767	99935	73832	26168	00065	26233	52
9		34	48	25	12		73997	99934	74063	25937	00066	26003	51
10	11	34	40	0	25	20	8 74226	9 99934	8 74292	11 26708	10 00066	11 26774	50
11		34	32	25	28		74454	99933	74521	25479	00067	25546	49
12		34	24	25	36		74680	99932	74748	25252	00068	25320	48
13		34	16	25	44		74906	99932	74974	25026	00068	25094	47
14		34	8	25	52		75130	99931	75199	24801	00069	24870	46
15	11	34	0	0	26	0	8 75353	9 99930	8 75423	11 24577	10 00070	11 24647	45
16		33	52	26	8		75576	99929	75645	24355	00071	24425	44
17		33	44	26	16		75795	99929	75867	24133	00071	24205	43
18		33	36	26	24		76015	99928	76087	23913	00072	23985	42
19		33	28	26	32		76234	99927	76306	23694	00073	23766	41
20	11	33	20	0	26	40	8 76451	9 99926	8 76523	11 23475	10 00074	11 23549	40
21		33	12	26	48		76667	99926	76742	23258	00074	23333	39
22		33	4	26	56		76883	99925	76958	23042	00076	23117	38
23		32	56	27	4		77097	99924	77173	22827	00076	22903	37
24		32	48	27	12		77310	99923	77387	22613	00077	22690	36
25	11	32	40	0	27	20	8 77522	9 99923	8 77600	11 22400	10 00077	11 22478	35
26		32	32	27	28		77733	99922	77811	22189	00078	22267	34
27		32	24	27	36		77943	99921	78022	21978	00079	22057	33
28		32	16	27	44		78152	99920	78232	21768	00080	21848	32
29		32	8	27	52		78360	99920	78441	21559	00080	21640	31
30	11	32	0	0	28	0	8 78568	9 99919	8 78649	11 21351	10 00081	11 21432	30
31		31	52	28	8		78774	99918	78855	21145	00082	21226	29
32		31	44	28	16		78979	99917	79061	20939	00082	21117	28
33		31	36	28	24		79183	99917	79266	20734	00083	20817	27
34		31	28	28	32		79386	99916	79470	20530	00084	20614	26
35	11	31	20	0	28	40	8 79588	9 99915	8 79673	11 20327	10 00085	11 20412	25
36		31	12	28	48		79789	99914	79875	20125	00086	20211	24
37		31	4	28	56		79990	99913	80076	19924	00087	20010	23
38		30	56	29	4		80189	99913	80277	19723	00087	19811	22
39		30	48	29	12		80388	99912	80476	19524	00088	19612	21
40	11	30	40	0	29	20	8 80585	9 99911	8 80674	11 19326	10 00089	11 19415	20
41		30	32	29	28		80782	99910	80872	19128	00090	19218	19
42		30	24	29	36		80978	99909	81068	18932	00091	19022	18
43		30	16	29	44		81173	99909	81264	18736	00091	18827	17
44		30	8	29	52		81367	99908	81459	18541	00092	18633	16
45	11	30	0	0	30	0	8 81560	9 99907	8 81653	11 18347	10 00093	11 18440	15
46		29	52	30	8		81752	99906	81846	18154	00094	18248	14
47		29	44	30	16		81944	99905	82038	17962	00095	18056	13
48		29	36	30	24		82134	99904	82230	17770	00096	17866	12
49		29	28	30	32		82324	99904	82420	17580	00096	17676	11
50	11	29	20	0	30	40	8 82513	9 99903	8 82610	11 17390	10 00097	11 17487	10
51		29	12	30	48		82701	99902	82799	17201	00098	17299	9
52		29	4	30	56		82888	99901	82987	17013	00099	17112	8
53		28	56	31	4		83073	99900	83175	16825	00100	16925	7
54		28	48	31	12		83261	99899	83361	16639	00101	16739	6
55	11	28	40	0	31	20	8 83446	9 99898	8 83547	11 16453	10 00102	11 16554	5
56		28	32	31	28		83630	99898	83732	16264	00102	16370	4
57		28	24	31	36		83813	99897	83916	16084	00103	16187	3
58		28	16	31	44		83996	99896	84100	15900	00104	16004	2
59		28	8	31	52		84177	99895	84282	15718	00105	15823	1
60		28	0	32	0		84358	99894	84464	15536	00106	15642	0
M	Hour	Min	Hour	Min	Co-sine	Sine	Co-tang	Tangent	Co-secant	Secant	M		

33 Degs.

Degs. 34

4 Degs.

Degs. 175.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 28 0	0 32 0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	27 52	32 8	84539	99893	84646	15354	00107	15461	59
2	27 44	32 16	84718	99892	85826	15174	00108	15282	58
3	27 36	32 24	84897	99891	85006	14994	00109	15103	57
4	27 28	32 32	85075	99891	85185	14815	00109	14925	56
5	11 27 20	0 32 40	8.85252	9.99890	8.85363	11.14637	10.00110	11.14748	55
6	27 12	32 48	85429	99889	85540	14460	00111	14571	54
7	27 4	32 56	85605	99888	85717	14283	00112	14395	53
8	26 56	33 4	85780	99887	85893	14107	00113	14220	52
9	26 48	33 12	85955	99886	86069	13931	00114	14045	51
10	11 26 40	0 33 20	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	26 32	33 28	86301	99884	86417	13583	00116	13699	49
12	26 24	33 36	86474	99883	86591	13409	00117	13526	48
13	26 16	33 44	86645	99882	86763	13237	00118	13355	47
14	26 8	33 52	86816	99881	86935	13065	00119	13184	46
15	11 26 0	0 34 0	8.86987	9.99880	8.87106	11.12894	10.00120	11.13013	45
16	25 52	34 8	87156	99879	87277	12723	00121	12844	44
17	25 44	34 16	87325	99879	87447	12553	00121	12675	43
18	25 36	34 24	87494	99878	87616	12384	00122	12506	42
19	25 28	34 32	87661	99877	87785	12215	00123	12339	41
20	11 25 20	0 34 40	8.87829	9.99876	8.87953	11.12047	10.00124	11.12171	40
21	25 12	34 48	87995	99875	88120	11880	00125	12005	39
22	25 4	34 56	88161	99874	88287	11713	00126	11839	38
23	24 56	35 4	88326	99873	88453	11547	00127	11674	37
24	24 48	35 12	88490	99872	88618	11382	00128	11510	36
25	11 24 40	0 35 20	8.88654	9.99871	8.88783	11.11217	10.00129	11.11346	35
26	24 32	35 28	88817	99870	88948	11052	00130	11183	34
27	24 24	35 36	88980	99869	89111	10889	00131	11020	33
28	24 16	35 44	89142	99868	89274	10726	00132	10858	32
29	24 8	35 52	89304	99867	89437	10563	00133	10696	31
30	11 24 0	0 36 0	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	23 52	36 8	89625	99865	89760	10240	00135	10375	29
32	23 44	36 16	89784	99864	89920	10080	00136	10216	28
33	23 36	36 24	89943	99863	90080	99920	00137	10057	27
34	23 28	36 32	90102	99862	90240	99760	00138	99898	26
35	11 23 20	0 36 40	8.90260	9.99861	8.90399	11.09601	10.00139	11.09740	25
36	23 12	36 48	90417	99860	90557	99443	00140	99583	24
37	23 4	36 56	90574	99859	90715	99285	00141	99426	23
38	22 56	37 4	90730	99858	90872	99128	00142	99270	22
39	22 48	37 12	90885	99857	91029	98971	00143	99115	21
40	11 22 40	0 37 20	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	22 32	37 28	91195	99855	91340	98660	00145	98805	19
42	22 24	37 36	91349	99854	91495	98505	00146	98651	18
43	22 16	37 44	91502	99853	91650	98350	00147	98498	17
44	22 8	37 52	91655	99852	91803	98197	00148	98345	16
45	11 22 0	0 38 0	8.91807	9.99851	8.91957	11.08043	10.00149	11.08193	15
46	21 52	38 8	91959	99850	92110	97890	00150	98041	14
47	21 44	38 16	92110	99848	92262	97738	00152	97890	13
48	21 36	38 24	92261	99847	92414	97586	00153	97739	12
49	21 28	38 32	92411	99846	92565	97435	00154	97589	11
50	11 21 20	0 38 40	8.92561	9.99845	8.92716	11.07284	10.00155	11.07439	10
51	21 12	38 48	92710	99844	92866	97134	00156	97290	9
52	21 4	38 56	92859	99843	93016	96984	00157	97141	8
53	20 56	39 4	93007	99842	93165	96835	00158	96993	7
54	20 48	39 12	93154	99841	93313	96687	00159	96846	6
55	11 20 40	0 39 20	8.93301	9.99840	8.93462	11.06538	10.00160	11.06699	5
56	20 32	39 28	93448	99839	93609	96391	00161	96552	4
57	20 24	39 36	93594	99838	93756	96244	00162	96406	3
58	20 16	39 44	93740	99837	93903	96097	00163	96260	2
59	20 8	39 52	93885	99836	94049	95951	00164	96115	1
60	20 0	40 0	94030	99834	94195	95805	00166	95970	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

94 Degs.

Degs. 85.

TABLE XXVII.
Log. Sines, Tangents and Secants.

189

5 Degs.

Degs. 174.

M	Hour	Min.	Hour	Min.	Sine.	Co-sine.	Tangent	Co-tang	Secant	Co-secant	M		
0	11	20	0	0	40	0	8 94030	9 99834	8 94195	11 05805	10 00165	11 06970	60
1		19	52	40	8		94174	99833	94340	05660	00167	05826	59
2		19	44	40	16		94317	99832	94485	05515	00168	05683	58
3		19	36	40	24		94461	99831	94630	05370	00169	05539	57
4		19	28	40	32		94603	99830	94773	05227	00170	05395	56
5	11	19	20	0	40	40	8 94746	9 99829	8 94917	11 05083	10 00171	11 05254	55
6		19	12	40	48		94887	99828	95060	04940	00172	05113	54
7		19	4	40	56		95029	99827	95202	04797	00173	04970	53
8		18	56	41	4		95170	99825	95344	04656	00175	04830	52
9		18	48	41	12		95310	99824	95486	04514	00176	04690	51
10	11	18	40	0	41	20	8 95460	9 99823	8 95627	11 04373	10 00177	11 04550	50
11		18	32	41	28		95589	99822	95767	04231	00178	04411	49
12		18	24	41	36		95728	99821	95908	04092	00179	04272	48
13		18	16	41	44		95867	99820	96047	03953	00180	04133	47
14		18	8	41	52		96005	99819	96187	03813	00181	03995	46
15	11	18	0	0	42	0	8 96143	9 99817	8 96325	11 03675	10 00183	11 03857	45
16		17	52	42	8		96280	99816	96464	03536	00184	03718	44
17		17	44	42	16		96417	99815	96602	03398	00185	03579	43
18		17	36	42	24		96553	99814	96739	03261	00186	03447	42
19		17	28	42	32		96689	99813	96877	03123	00187	03311	41
20	11	17	20	0	42	40	8 96825	9 99812	8 97013	11 02987	10 00188	11 03175	40
21		17	12	42	48		96960	99810	97150	02850	00189	03040	39
22		17	4	42	56		97095	99809	97289	02715	00191	02905	38
23		16	56	43	4		97229	99808	97421	02579	00192	02771	37
24		16	48	43	12		97363	99807	97556	02444	00193	02637	36
25	11	16	40	0	43	20	8 97496	9 99806	8 97691	11 02309	10 00194	11 02500	35
26		16	32	43	28		97629	99804	97825	02175	00196	02371	34
27		16	24	43	36		97762	99803	97959	02041	00197	02238	33
28		16	16	43	44		97894	99802	98092	01908	00198	02106	32
29		16	8	43	52		98026	99801	98225	01775	00199	01974	31
30	11	16	0	0	44	0	8 98157	9 99800	8 98358	11 01642	10 00200	11 01843	30
31		15	52	44	8		98288	99798	98490	01510	00202	01710	29
32		15	44	44	16		98419	99797	98622	01378	00203	01581	28
33		15	36	44	24		98549	99796	98753	01247	00204	01452	27
34		15	28	44	32		98679	99795	98884	01116	00205	01321	26
35	11	15	20	0	44	40	8 98808	9 99793	8 99015	11 00985	10 00207	11 01192	25
36		15	12	44	48		98937	99792	99145	00855	00208	01061	24
37		15	4	44	56		99066	99791	99275	00725	00209	00930	23
38		14	56	45	4		99195	99790	99405	00595	00210	00800	22
39		14	48	45	12		99322	99788	99534	00466	00212	00671	21
40	11	14	40	0	45	20	8 99450	9 99787	8 99662	11 00338	10 00213	11 00549	20
41		14	32	45	28		99577	99786	99791	00209	00214	00420	19
42		14	24	45	36		99704	99785	99919	00081	00215	00296	18
43		14	16	45	44		99830	99783	10 00046	00954	00217	00170	17
44		14	8	45	52		99956	99782	00174	99826	00218	00044	16
45	11	14	0	0	46	0	9 00082	9 99781	9 00301	10 99699	10 00219	10 99918	15
46		13	52	46	8		00207	99780	00427	99571	00220	99793	14
47		13	44	46	16		00332	99778	00553	99447	00221	99668	13
48		13	36	46	24		00456	99777	00679	99321	00223	99544	12
49		13	28	46	32		00581	99776	00805	99195	00224	99419	11
50	11	13	20	0	46	40	9 00704	9 99775	9 00930	10 99070	10 00225	10 99296	10
51		13	12	46	48		00828	99773	01055	98945	00227	99172	9
52		13	4	46	56		00951	99772	01179	98821	00228	99049	8
53		12	56	47	4		01074	99771	01303	98697	00229	98926	7
54		12	48	47	12		01196	99769	01427	98573	00231	98804	6
55	11	12	40	0	47	20	9 01318	9 99768	9 01550	10 98450	10 00232	10 98676	5
56		12	32	47	28		01440	99767	01673	98327	00233	98550	4
57		12	24	47	36		01561	99765	01796	98204	00235	98439	3
58		12	16	47	44		01682	99764	01918	98082	00236	98318	2
59		12	8	47	52		01803	99763	02040	97960	00237	98197	1
60		12	0	48	0		01923	99761	02162	97838	00239	98077	0
M	Hour	Min.	Hour	Min.	Co-sine	Sine	Co-tang	Tangent	Co-secant	Secant	M		

55 Degs.

Degs. 84

TABLE XXVII.

Log. Sines, Tangents and Secants.

5 Degs.

Degs. 173.

M	Hour. m.	Hour. m.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 12 0	0 48 0	9.01923	9.99761	9.02162	10.97838	10.00239	10.98077	60
1	11 52	48 8	02043	99760	02283	97717	00240	97957	59
2	11 44	48 16	02163	99759	02404	97596	00241	97837	58
3	11 36	48 24	02283	99757	02525	97476	00243	97717	57
4	11 28	48 32	02402	99756	02645	97355	00244	97598	56
5	11 11 20	0 48 40	9.02520	9.99755	9.02766	10.97838	10.00245	10.97480	55
6	11 12	48 48	02639	99753	02885	97114	00247	97361	54
7	11 4	48 56	02757	99752	03005	96996	00248	97243	53
8	10 56	49 4	02874	99751	03124	96876	00249	97126	52
9	10 48	49 12	02992	99749	03242	96755	00251	97008	51
10	11 10 40	0 49 20	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	10 32	49 28	03226	99747	03479	96521	00253	96774	49
12	10 24	49 36	03342	99745	03597	96403	00255	96658	48
13	10 16	49 44	03458	99744	03714	96286	00256	96542	47
14	10 8	49 52	03574	99742	03832	96168	00258	96426	46
15	11 10 0	0 50 0	9.03690	9.99741	9.03948	10.96052	10.00259	10.96310	45
16	9 52	50 8	03805	99740	04065	95935	00260	96195	44
17	9 44	50 16	03920	99738	04181	95819	00262	96080	43
18	9 36	50 24	04034	99737	04297	95703	00263	95966	42
19	9 28	50 32	04149	99736	04413	95587	00264	95851	41
20	11 9 20	0 50 40	9.04262	9.99734	9.04523	10.95472	10.00266	10.95738	40
21	9 12	50 48	04376	99733	04643	95357	00267	95624	39
22	9 4	50 56	04490	99731	04768	95242	00269	95510	38
23	8 56	51 4	04603	99730	04873	95127	00270	95397	37
24	8 48	51 12	04715	99728	04987	95013	00272	95285	36
25	11 8 40	0 51 20	9.04828	9.99727	9.05101	10.94899	10.00273	10.95172	35
26	8 32	51 28	04940	99726	05214	94786	00274	95060	34
27	8 24	51 36	05052	99724	05328	94672	00276	94948	33
28	8 16	51 44	05164	99723	05441	94559	00277	94836	32
29	8 8	51 52	05275	99721	05553	94447	00279	94725	31
30	11 8 0	0 52 0	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	7 52	52 8	05497	99718	05778	94222	00282	94503	29
32	7 44	52 16	05607	99717	05890	94110	00283	94393	28
33	7 36	52 24	05717	99716	06002	93998	00284	94283	27
34	7 28	52 32	05827	99714	06113	93887	00286	94173	26
35	11 7 20	0 52 40	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
36	7 12	52 48	06046	99711	06335	93665	00289	93954	24
37	7 4	52 56	06155	99710	06446	93553	00290	93845	23
38	6 56	53 4	06264	99708	06556	93444	00292	93736	22
39	6 48	53 12	06372	99707	06666	93334	00293	93628	21
40	11 6 40	0 53 20	9.06481	9.99705	9.06775	10.93225	10.00295	10.93519	20
41	6 32	53 28	06589	99704	06885	93115	00296	93411	19
42	6 24	53 36	06696	99702	06994	93006	00298	93304	18
43	6 16	53 44	06804	99701	07103	92897	00299	93196	17
44	6 8	53 52	06911	99699	07211	92789	00301	93089	16
45	11 6 0	0 54 0	9.07018	9.99698	9.07320	10.92680	10.00302	10.92982	15
46	5 52	54 8	07124	99696	07428	92572	00304	92876	14
47	5 44	54 16	07231	99695	07536	92464	00305	92769	13
48	5 36	54 24	07337	99693	07643	92357	00307	92663	12
49	5 28	54 32	07442	99692	07751	92249	00308	92558	11
50	11 5 20	0 54 40	9.07548	9.99690	9.07858	10.92142	10.00310	10.92432	10
51	5 12	54 48	07653	99689	07964	92036	00311	92347	9
52	5 4	54 56	07758	99687	08071	91929	00313	92242	8
53	4 56	55 4	07863	99686	08177	91823	00314	92137	7
54	4 48	55 12	07968	99684	08283	91717	00316	92032	6
55	11 4 40	0 55 20	9.08072	9.99683	9.08389	10.91611	10.00317	10.91928	5
56	4 32	55 28	08176	99681	08495	91505	00319	91824	4
57	4 24	55 36	08280	99680	08600	91400	00320	91720	3
58	4 16	55 44	08383	99678	08705	91295	00322	91617	2
59	4 8	55 52	08486	99677	08810	91190	00323	91514	1
60	4 0	56 0	08589	99675	08914	91086	00325	91411	0
M	Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

96 Degs

Degs. 83.

TABLE XXVII.
Log. Sines, Tangents and Secants.

191

7 Degs.

Degs. 172.

M	Hour. M.	Hour. M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 4 0	0 56 0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	3 52	56 8	08692	99674	09019	90981	00326	91308	59
2	3 44	56 16	08795	99672	09123	90877	00327	91205	58
3	3 36	56 24	08897	99670	09227	90773	00330	91103	57
4	3 28	56 32	08999	99668	09330	90670	00331	91001	56
5	11 3 20	0 56 40	9.09101	9.99667	9.09434	10.90566	10.00333	10.90899	55
6	3 12	56 48	09202	99666	09537	90463	00334	90798	54
7	3 4	56 56	09304	99664	09640	90360	00336	90696	53
8	2 56	57 4	09406	99663	09742	90258	00337	90595	52
9	2 48	57 12	09506	99661	09845	90156	00339	90494	51
10	11 2 40	0 57 20	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	2 32	57 28	09707	99658	10049	89951	00342	90293	49
12	2 24	57 36	09807	99656	10150	89850	00344	90193	48
13	2 16	57 44	09907	99655	10252	89748	00345	90093	47
14	2 8	57 52	10006	99653	10353	89647	00347	89994	46
15	11 2 0	0 58 0	9.10106	9.99651	9.10454	10.89546	10.00349	10.89894	45
16	1 52	58 8	10205	99650	10555	89445	00350	89793	44
17	1 44	58 16	10304	99648	10656	89344	00352	89696	43
18	1 36	58 24	10402	99647	10756	89244	00353	89598	42
19	1 28	58 32	10501	99645	10856	89144	00355	89499	41
20	11 1 20	0 58 40	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	1 12	58 48	10697	99642	11056	88944	00358	89303	39
22	1 4	58 56	10795	99640	11155	88845	00360	89205	38
23	0 56	59 4	10893	99638	11254	88746	00362	89107	37
24	0 48	59 12	10990	99637	11353	88647	00363	89010	36
25	11 0 40	0 59 20	9.11087	9.99635	9.11452	10.88548	10.00365	10.88913	35
26	0 32	59 28	11184	99633	11551	88449	00367	88816	34
27	0 24	59 36	11281	99632	11649	88351	00368	88719	33
28	0 16	59 44	11377	99630	11747	88253	00370	88623	32
29	0 8	59 52	11474	99629	11845	88155	00371	88526	31
30	11 0 0	1 0 0	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
31	10 59 52	0 8	11666	99625	12040	87960	00375	88334	29
32	59 44	0 16	11761	99624	12138	87862	00376	88239	28
33	59 36	0 24	11857	99622	12235	87765	00378	88143	27
34	59 28	0 32	11952	99620	12332	87668	00380	88048	26
35	10 59 20	1 0 40	9.12047	9.99618	9.12428	10.87572	10.00382	10.87953	25
36	59 12	0 48	12142	99617	12525	87475	00383	87858	24
37	59 4	0 56	12236	99615	12621	87379	00385	87764	23
38	58 56	1 4	12331	99613	12717	87283	00387	87669	22
39	58 48	1 12	12425	99612	12812	87187	00388	87575	21
40	10 58 40	1 1 20	9.12519	9.99610	9.12909	10.87091	10.00390	10.87481	20
41	58 32	1 28	12612	99608	13004	86996	00392	87388	19
42	58 24	1 36	12706	99607	13099	86901	00393	87294	18
43	58 16	1 44	12799	99606	13194	86806	00395	87201	17
44	58 8	1 52	12892	99603	13289	86711	00397	87108	16
45	10 58 0	1 2 0	9.12985	9.99601	9.13384	10.86616	10.00399	10.87015	15
46	57 52	2 8	13078	99600	13478	86522	00400	86922	14
47	57 44	2 16	13171	99598	13573	86427	00402	86829	13
48	57 36	2 24	13263	99596	13667	86333	00404	86735	12
49	57 28	2 32	13355	99595	13761	86239	00405	86643	11
50	10 57 20	1 2 40	9.13447	9.99593	9.13854	10.86146	10.00407	10.86553	10
51	57 12	2 48	13539	99591	13948	86052	00409	86461	9
52	57 4	2 56	13630	99589	14041	85959	00411	86370	8
53	56 56	3 4	13722	99588	14134	85866	00412	86278	7
54	56 48	3 12	13813	99586	14227	85773	00414	86187	6
55	10 56 40	1 3 20	9.13904	9.99584	9.14320	10.85680	10.00416	10.86096	5
56	56 32	3 28	13994	99582	14312	85688	00418	86006	4
57	56 24	3 36	14085	99581	14404	85596	00419	85915	3
58	56 16	3 44	14175	99579	14497	85503	00421	85825	2
59	56 8	3 52	14266	99577	14588	85411	00423	85735	1
60	56 0	4 0	14356	99575	14680	85320	00425	85644	0
M	Hour. M.	Hour. M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

57 Degs.

Degs. 52.

TABLE XXVII.

193

Log. Sines, Tangents and Secants.

9 Degs.

Degs. 170.

M	Hour-M.	Hour-M.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M
0	10 48 0	1 12 0	9.19433	9.99462	9.19971	10.80029	10.00538	10.00567	60
1	47 52	12 8	19513	99460	20053	79947	00540	99467	59
2	47 14	12 16	19592	99458	20134	79866	00542	99448	58
3	47 36	12 24	19672	99456	20216	79784	00544	99428	57
4	47 28	12 32	19751	99454	20297	79703	00546	99409	56
5	10 47 20	1 12 40	9.19830	9.99452	9.20378	10.79622	10.00548	10.00170	55
6	47 12	12 48	19909	99450	20459	79541	00550	99391	54
7	47 4	12 56	19988	99448	20540	79460	00552	99372	53
8	46 56	13 4	20067	99446	20621	79379	00554	99353	52
9	46 48	13 12	20145	99444	20701	79299	00556	99333	51
10	10 46 40	1 13 20	9.20223	9.99442	9.20782	10.79216	10.00558	10.79777	50
11	46 32	13 28	20302	99440	20862	79138	00560	99318	49
12	46 24	13 36	20380	99438	20942	79058	00562	99299	48
13	46 16	13 44	20458	99436	21022	78978	00564	99280	47
14	46 8	13 52	20535	99434	21102	78898	00566	99260	46
15	10 46 0	1 14 0	9.20613	9.99432	9.21182	10.78814	10.00568	10.79387	45
16	45 52	14 8	20691	99429	21261	78739	00571	99249	44
17	45 44	14 16	20769	99427	21341	78659	00573	99230	43
18	45 36	14 24	20845	99425	21420	78580	00575	99210	42
19	45 28	14 32	20922	99423	21499	78501	00577	99191	41
20	10 45 20	1 14 40	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	45 12	14 48	21076	99419	21657	78423	00581	99172	39
22	45 4	14 56	21153	99417	21736	78344	00583	99153	38
23	44 56	15 4	21229	99415	21814	78264	00585	99133	37
24	44 48	15 12	21306	99413	21893	78185	00587	99114	36
25	10 44 40	1 15 20	9.21382	9.99411	9.21971	10.78029	10.00589	10.78618	35
26	44 32	15 28	21458	99409	22049	77951	00591	99095	34
27	44 24	15 36	21534	99407	22127	77873	00593	99076	33
28	44 16	15 44	21610	99404	22203	77795	00596	99057	32
29	44 8	15 52	21685	99402	22282	77717	00598	99038	31
30	10 44 0	1 16 0	9.21761	9.99400	9.22361	10.77639	10.00600	10.78229	30
31	43 52	16 8	21836	99398	22438	77562	00602	99019	29
32	43 44	16 16	21912	99396	22516	77484	00604	98999	28
33	43 36	16 24	21987	99394	22593	77407	00606	98980	27
34	43 28	16 32	22062	99392	22670	77330	00608	98961	26
35	10 43 20	1 16 40	9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
36	43 12	16 48	22211	99388	22824	77176	00612	98942	24
37	43 4	16 56	22286	99385	22901	77099	00615	98923	23
38	42 56	17 4	22361	99383	22977	77023	00617	98904	22
39	42 48	17 12	22435	99381	23054	76946	00619	98885	21
40	10 42 40	1 17 20	9.22509	9.99379	9.23130	10.76870	10.00621	10.77491	20
41	42 32	17 2	22583	99377	23206	76794	00623	98866	19
42	42 24	17 36	22657	99375	23283	76717	00625	98847	18
43	42 16	17 44	22731	99372	23360	76641	00628	98828	17
44	42 8	17 52	22805	99370	23435	76565	00630	98809	16
45	10 42 0	1 18 0	9.22973	9.99368	9.23510	10.76490	10.00632	10.77122	15
46	41 52	18 8	22952	99366	23586	76414	00634	98790	14
47	41 44	18 16	23025	99364	23661	76339	00636	98771	13
48	41 36	18 24	23098	99362	23737	76263	00638	98752	12
49	41 28	18 32	23171	99359	23812	76188	00641	98733	11
50	10 41 20	1 18 40	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	41 12	18 48	23317	99355	23962	76038	00645	98714	9
52	41 4	18 56	23390	99353	24037	75963	00647	98695	8
53	40 56	19 4	23462	99351	24112	75888	00649	98676	7
54	40 48	19 12	23535	99348	24186	75814	00652	98657	6
55	10 40 40	1 19 20	9.23707	9.99346	9.24261	10.75739	10.00654	10.76393	5
56	40 32	19 28	23679	99344	24335	75665	00656	98638	4
57	40 24	19 36	23752	99342	24410	75590	00658	98619	3
58	40 16	19 44	23823	99340	24484	75516	00660	98600	2
59	40 8	19 52	23895	99337	24558	75442	00663	98581	1
60	40 0	20 0	23967	99335	24632	75368	00665	98562	0
M	Hour-M.	Hour-M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

99 Degs.

A a

Degs. 50.

TABLE XXVII. Log. Sines, Tangents and Secants.

10 Degs.

Degs. 169

M	Hour	m	Hour	m	Sine	Co-sine	Tangent	Co-tang	Secant	Co-secant	M		
0	10	40	0	1	20	0	9 23967	9 99345	9 24032	10 75368	10 00665	10 76033	60
1		39	52		20	8	24039	99333	24706	75294	00667	75961	59
2		39	44		20	16	24110	99331	24779	75221	00669	75890	58
3		39	36		20	24	24181	99328	24853	75147	00672	75819	57
4		39	28		20	32	24253	99326	24926	75074	00674	75747	56
5	10	39	20	1	20	40	9 24324	9 99324	9 25000	10 75000	10 00676	10 75676	55
6		39	12		20	48	24395	99322	25073	74927	00678	75603	54
7		39	4		20	56	24466	99319	25146	74854	00681	75534	53
8		38	56		21	4	24536	99317	25219	74781	00683	75464	52
9		38	48		21	12	24607	99315	25292	74708	00685	75393	51
10	10	38	40	1	21	20	9 24677	9 99313	9 25363	10 74633	10 00687	10 75323	50
11		38	32		21	28	24748	99310	25437	74563	00690	75252	49
12		38	24		21	36	24818	99308	25510	74490	00692	75182	48
13		38	16		21	44	24888	99306	25582	74418	00694	75112	47
14		38	8		21	52	24958	99304	25655	74345	00696	75042	46
15	10	38	0	1	22	0	9 25028	9 99301	9 25727	10 74273	10 00699	10 74972	45
16		37	52		22	8	25098	99299	25799	74201	00701	74902	44
17		37	44		22	16	25168	99297	25871	74129	00703	74832	43
18		37	36		22	24	25237	99294	25943	74057	00706	74763	42
19		37	28		22	32	25307	99292	26015	73985	00708	74693	41
20	10	37	20	1	22	40	9 25376	9 99290	9 26086	10 73914	10 00710	10 74624	40
21		37	12		22	48	25445	99288	26158	73842	00712	74553	39
22		37	4		22	56	25514	99286	26229	73771	00715	74483	38
23		36	56		23	4	25583	99283	26301	73699	00717	74412	37
24		36	48		23	12	25652	99281	26372	73628	00719	74342	36
25	10	36	40	1	23	20	9 25721	9 99278	9 26443	10 73557	10 00722	10 74272	35
26		36	32		23	28	25790	99276	26514	73486	00724	74202	34
27		36	24		23	36	25858	99274	26585	73415	00726	74132	33
28		36	16		23	44	25927	99271	26656	73344	00729	74062	32
29		36	8		23	52	25995	99269	26726	73274	00731	74005	31
30	10	36	0	1	24	0	9 26063	9 99267	9 26797	10 73203	10 00733	10 73937	30
31		35	52		24	8	26131	99264	26867	73133	00736	73869	29
32		35	44		24	16	26199	99262	26937	73063	00738	73801	28
33		35	36		24	24	26267	99260	27008	72992	00740	73733	27
34		35	28		24	32	26335	99257	27078	72922	00743	73665	26
35	10	35	20	1	24	40	9 26403	9 99255	9 27148	10 72852	10 00745	10 73597	25
36		35	12		24	48	26470	99252	27218	72782	00748	73530	24
37		35	4		24	56	26538	99250	27288	72712	00750	73462	23
38		34	56		25	4	26605	99248	27357	72643	00753	73395	22
39		34	48		25	12	26672	99246	27427	72573	00755	73328	21
40	10	34	40	1	25	20	9 26739	9 99243	9 27496	10 72504	10 00757	10 73261	20
41		34	32		25	28	26806	99241	27566	72434	00759	73194	19
42		34	24		25	36	26873	99238	27635	72365	00762	73127	18
43		34	16		25	44	26940	99236	27704	72296	00764	73060	17
44		34	8		25	52	27007	99233	27773	72227	00767	72993	16
45	10	34	0	1	26	0	9 27073	9 99231	9 27842	10 72158	10 00769	10 72927	15
46		33	52		26	8	27140	99229	27911	72089	00771	72860	14
47		33	44		26	16	27206	99226	27980	72020	00774	72794	13
48		33	36		26	24	27273	99224	28049	71951	00776	72727	12
49		33	28		26	32	27339	99221	28117	71883	00779	72661	11
50	10	33	20	1	26	40	9 27405	9 99219	9 28186	10 71814	10 00781	10 72598	10
51		33	12		26	48	27471	99217	28254	71746	00783	72529	9
52		33	4		26	56	27537	99214	28323	71677	00786	72463	8
53		32	56		27	4	27602	99212	28391	71609	00788	72396	7
54		32	48		27	12	27668	99209	28459	71541	00791	72332	6
55	10	32	40	1	27	20	9 27734	9 99207	9 28527	10 71473	10 00793	10 72266	5
56		32	32		27	28	27799	99204	28595	71405	00796	72201	4
57		32	24		27	36	27864	99202	28662	71338	00798	72136	3
58		32	16		27	44	27930	99200	28730	71270	00800	72070	2
59		32	8		27	52	27995	99197	28798	71202	00803	72005	1
60		32	0		28	0	28060	99195	28865	71135	00805	71940	0
M	Hour	m	Hour	m	Co-sine	Sine	Co-tang	Tangent	Co-secant	Secant	M		

166 Degs.

Degs. 71

195

Log. Sines, Tangents and Secants.

Degs.				Deg. 168.						
Hour	M.	Hour	M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
10	32	0	1 28 0	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
	31	52	28 8	28125	99192	28933	71067	00808	71875	59
	31	44	28 16	28130	99190	29000	71000	00810	71810	58
	31	36	28 24	28254	99187	29067	70933	00813	71745	57
	31	28	28 32	28319	99185	29134	70866	00815	71681	56
10	31	20	1 28 40	9.28384	9.99182	9.29201	10.70799	10.00818	10.71616	55
	31	12	28 48	28448	99180	29268	70732	00820	71552	54
	31	4	28 56	28512	99177	29335	70665	00823	71488	53
	30	56	29 4	28577	99175	29402	70598	00825	71423	52
	30	48	29 12	28641	99172	29468	70532	00828	71359	51
10	30	40	1 29 20	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
	30	32	29 28	28769	99167	29601	70399	00833	71231	49
	30	24	29 36	28833	99165	29668	70332	00835	71167	48
	30	16	29 44	28896	99162	29734	70266	00838	71104	47
	30	8	29 52	28960	99160	29800	70200	00840	71040	46
10	30	0	1 30 0	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	45
	29	52	30 8	29087	99155	29932	70068	00845	70913	44
	29	44	30 16	29150	99152	29998	70002	00848	70850	43
	29	36	30 24	29214	99150	30064	69936	00850	70786	42
	29	28	30 32	29277	99147	30130	69870	00853	70723	41
10	29	20	1 30 40	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
	29	12	30 48	29403	99142	30261	69732	00858	70597	39
	29	4	30 56	29466	99140	30326	69674	00860	70534	38
	28	56	31 4	29529	99137	30391	69609	00863	70471	37
	28	48	31 12	29591	99135	30457	69543	00865	70409	36
10	28	40	1 31 20	9.29654	9.99132	9.30522	10.69478	10.00868	10.70346	35
	28	32	31 28	29716	99130	30587	69413	00870	70284	34
	28	24	31 36	29779	99127	30652	69348	00873	70221	33
	28	16	31 44	29841	99124	30717	69283	00876	70159	32
	28	8	31 52	29903	99122	30782	69218	00878	70097	31
10	28	0	1 32 0	9.29966	9.99119	9.30846	10.69154	10.00881	10.70034	30
	27	52	32 8	30028	99117	30911	69089	00883	69972	29
	27	44	32 16	30090	99114	30975	69025	00886	69910	28
	27	36	32 24	30151	99112	31040	68960	00888	69849	27
	27	28	32 32	30213	99109	31104	68896	00891	69787	26
10	27	20	1 32 40	9.30275	9.99106	9.31168	10.68832	10.00894	10.69725	25
	27	12	32 48	30336	99104	31233	68767	00896	69664	24
	27	4	32 56	30398	99101	31297	68703	00899	69602	23
	26	56	33 4	30459	99099	31361	68639	00901	69541	22
	26	48	33 12	30521	99096	31425	68575	00904	69479	21
10	26	40	1 33 20	9.30582	9.99093	9.31489	10.68511	10.00907	10.69418	20
	26	32	33 28	30643	99091	31552	68448	00909	69357	19
	26	24	33 36	30704	99088	31616	68384	00912	69296	18
	26	16	33 44	30765	99086	31679	68321	00914	69235	17
	26	8	33 52	30826	99083	31743	68257	00917	69174	16
10	26	0	1 34 0	9.30887	9.99080	9.31806	10.68194	10.00920	10.69113	15
	25	52	34 8	30947	99078	31870	68130	00922	69053	14
	25	44	34 16	31008	99075	31933	68067	00925	68992	13
	25	36	34 24	31068	99072	31996	68004	00928	68932	12
	25	28	34 32	31129	99070	32059	67941	00930	68871	11
10	25	20	1 34 40	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
	25	12	34 48	31250	99064	32185	67815	00936	68750	9
	25	4	34 56	31310	99062	32248	67752	00938	68690	8
	24	56	35 4	31370	99059	32311	67689	00941	68630	7
	24	48	35 12	31430	99056	32373	67627	00944	68570	6
10	24	40	1 35 20	9.31490	9.99054	9.32436	10.67564	10.00946	10.68510	5
	24	32	35 28	31549	99051	32498	67502	00949	68451	4
	24	24	35 36	31609	99048	32561	67439	00952	68391	3
	24	16	35 44	31669	99046	32623	67377	00954	68331	2
	24	8	35 52	31728	99043	32685	67315	00957	68272	1
	24	0	36 0	31788	99040	32747	67253	00960	68212	0
Hour	M.	Hour	M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M
Degs.				Degs. 78.						

Dega.

Dege. 78.

TABLE XXVII.
Log. Sines, Tangents and Secants.

12 Days										Deg. 17	
51	Hour. m.	Hour. m.	Sine.	Co-sine	Tangent	Co-tang.	Secant	Co-secant.	51		
0	10 24 0	1 36 0	9 31783	9 99010	9 32747	10 67253	10 00960	10 67253	20		
1	24 32	36 8	31847	99048	32810	67190	00963	67193	34		
2	24 44	36 16	31907	99085	32872	67128	00965	67093	54		
3	24 36	36 24	31966	99122	32933	67067	00968	67034	57		
4	24 28	36 32	32025	99159	32995	67005	00970	67073	36		
5	10 23 20	1 36 40	9 32084	9 99197	9 33057	10 66943	10 00973	10 67916	35		
6	23 12	36 48	32143	99234	33119	66881	00976	67857	54		
7	23 4	36 56	32202	99271	33180	66819	00978	67799	53		
8	22 56	37 4	32261	99309	33242	66757	00981	67739	52		
9	22 48	37 12	32319	99346	33303	66695	00984	67681	51		
10	10 22 40	1 37 20	9 32378	9 99384	9 33365	10 66635	10 00987	10 67622	50		
11	22 32	37 28	32437	99421	33426	66574	00989	67563	49		
12	22 24	37 36	32495	99458	33487	66512	00992	67505	48		
13	22 16	37 44	32553	99495	33548	66450	00995	67447	47		
14	22 8	37 52	32612	99532	33609	66389	00998	67389	46		
15	10 22 0	1 38 0	9 32670	9 99570	9 33670	10 66330	10 01000	10 67330	45		
16	21 52	38 8	32728	99607	33731	66269	01003	67272	44		
17	21 44	38 16	32786	99644	33792	66208	01006	67214	43		
18	21 36	38 24	32844	99681	33853	66147	01009	67156	42		
19	21 28	38 32	32902	99718	33913	66085	01011	67098	41		
20	10 21 20	1 38 40	9 32960	9 99756	9 33974	10 66026	10 01014	10 67040	40		
21	21 12	38 48	33018	99793	34034	65965	01017	66982	39		
22	21 4	38 56	33075	99830	34095	65903	01020	66925	38		
23	20 56	39 4	33133	99867	34155	65843	01022	66867	37		
24	20 48	39 12	33190	99904	34215	65781	01025	66810	36		
25	10 20 40	1 39 20	9 33248	9 99942	9 34276	10 65724	10 01028	10 66752	35		
26	20 32	39 28	33305	99979	34336	65664	01031	66695	34		
27	20 24	39 36	33362	99967	34396	65604	01033	66638	33		
28	20 16	39 44	33420	99964	34456	65544	01036	66580	32		
29	20 8	39 52	33477	99961	34516	65484	01039	66523	31		
30	10 20 0	1 40 0	9 33534	9 99958	9 34576	10 65424	10 01042	10 66466	30		
31	19 52	40 8	33591	99955	34635	65363	01045	66409	29		
32	19 44	40 16	33647	99953	34695	65303	01047	66353	28		
33	19 36	40 24	33704	99950	34755	65243	01050	66296	27		
34	19 28	40 32	33761	99947	34814	65183	01053	66239	26		
35	10 19 20	1 40 40	9 33812	9 99944	9 34874	10 65126	10 01056	10 66182	25		
36	19 12	40 48	33874	99941	34933	65067	01059	66126	24		
37	19 4	40 56	33931	99938	34992	65008	01062	66069	23		
38	18 56	41 4	33987	99935	35051	64949	01064	66013	22		
39	18 48	41 12	34043	99933	35111	64889	01067	65957	21		
40	10 18 40	1 41 20	9 34100	9 99930	9 35170	10 64830	10 01070	10 65900	20		
41	18 32	41 28	34156	99927	35229	64771	01073	65844	19		
42	18 24	41 36	34212	99924	35288	64712	01076	65788	18		
43	18 16	41 44	34268	99921	35347	64653	01079	65732	17		
44	18 8	41 52	34324	99919	35405	64595	01081	65676	16		
45	10 18 0	1 42 0	9 34380	9 99916	9 35464	10 64536	10 01084	10 65620	15		
46	17 52	42 8	34436	99913	35523	64477	01087	65564	14		
47	17 44	42 16	34491	99910	35581	64419	01090	65509	13		
48	17 36	42 24	34547	99907	35640	64360	01093	65453	12		
49	17 28	42 32	34602	99904	35698	64302	01096	65398	11		
50	10 17 20	1 42 40	9 34658	9 99901	9 35757	10 64243	10 01099	10 65342	10		
51	17 12	42 48	34713	99898	35815	64185	01102	65287	9		
52	17 4	42 56	34769	99896	35873	64127	01104	65231	8		
53	16 56	43 4	34824	99893	35931	64069	01107	65176	7		
54	16 48	43 12	34879	99890	35989	64011	01110	65121	6		
55	10 16 40	1 43 20	9 34934	9 99887	9 36047	10 63953	10 01113	10 65066	5		
56	16 32	43 28	34989	99884	36105	63895	01116	65011	4		
57	16 24	43 36	35044	99881	36163	63837	01119	64956	3		
58	16 16	43 44	35099	99878	36221	63779	01122	64901	2		
59	16 8	43 52	35154	99875	36279	63721	01125	64846	1		
60	16 0	44 0	35209	99872	36336	63664	01128	64791	0		
51	Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent	Co-secant	Secant.	51		

102 Days

Deg. 17

TABLE XXVII.

197

Log. Sines, Tangents and Secants.

13 Degs.

Degs. 166.

M	Hour. M.	Hour. M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 16 0	1 44 0	9.35299	9.9371	9.36336	10.63664	10.01128	10.64791	60
1	15 52	44 8	35263	93769	36394	63606	01131	64737	59
2	15 44	44 16	35110	93867	36452	63548	01133	64682	58
3	15 36	44 24	34973	93964	36509	63491	01136	64627	57
4	15 28	44 32	34827	94061	36566	63434	01139	64573	56
5	10 15 20	1 44 40	9.3541	9.9359	9.36424	10.63576	10.01142	10.64519	55
6	15 12	44 48	35336	93553	36581	63319	01145	64464	54
7	15 4	44 56	35.90	93522	36738	63262	01148	64410	53
8	14 56	45 4	35644	93449	36795	63205	01151	64356	52
9	14 48	45 12	35.98	93346	36852	63148	01154	64302	51
10	10 14 40	1 45 20	9.35732	9.93243	9.36909	10.63091	10.01157	10.64248	50
11	14 32	45 28	35.16	93240	36966	63034	01160	64194	49
12	14 24	45 36	35.00	93237	37023	62977	01163	64140	48
13	14 16	45 44	35914	93.34	37080	62920	01166	64086	47
14	14 8	45 52	35968	93.31	37137	62863	01169	64032	46
15	10 14 0	1 46 0	9.36022	9.93028	9.37193	10.62807	10.01172	10.63978	45
16	13 52	46 8	36073	93025	37250	62750	01175	63925	44
17	13 44	46 16	36129	93022	37306	62694	01178	63871	43
18	13 36	46 24	36182	93019	37363	62637	01181	63818	42
19	13 28	46 32	36.36	93016	37419	62581	01184	63764	41
20	10 13 20	1 46 40	9.36339	9.92819	9.37476	10.62524	10.01187	10.63711	40
21	13 12	46 48	36342	92810	37532	62468	01190	63658	39
22	13 4	46 56	36393	92807	37588	62412	01193	63605	38
23	12 56	47 4	36449	92804	37644	62356	01196	63551	37
24	12 48	47 12	36.02	92801	37700	62300	01199	63498	36
25	10 12 40	1 47 20	9.36553	9.92798	9.37756	10.62244	10.01202	10.63443	35
26	12 32	47 28	36603	92795	37812	62188	01205	63392	34
27	12 24	47 36	36660	92792	37868	62132	01208	63340	33
28	12 16	47 44	36713	92789	37924	62076	01211	63287	32
29	12 8	47 52	36768	92786	37980	62020	01214	63234	31
30	10 12 0	1 48 0	9.36819	9.92783	9.38033	10.61965	10.01217	10.63181	30
31	11 52	48 8	36.74	92780	38091	61909	01220	63129	29
32	11 44	48 16	36824	92777	38147	61853	01223	63076	28
33	11 36	48 24	36970	92774	38202	61798	01226	63024	27
34	11 28	48 32	37022	92771	38257	61743	01229	62972	26
35	10 11 20	1 48 40	9.37081	9.92768	9.38313	10.61687	10.01232	10.62919	25
36	11 12	48 48	37133	92765	38368	61632	01235	62867	24
37	11 4	48 56	37182	92762	38423	61577	01238	62815	23
38	10 36	49 4	37237	92759	38479	61521	01241	62763	22
39	10 28	49 12	37289	92756	38534	61466	01244	62711	21
40	10 10 40	1 49 20	9.37341	9.92753	9.38589	10.61411	10.01247	10.62639	20
41	10 32	49 28	37393	92750	38644	61356	01250	62607	19
42	10 24	49 36	37443	92746	38699	61301	01253	62555	18
43	10 16	49 44	37497	92743	38754	61246	01256	62505	17
44	10 8	49 52	37549	92740	38808	61192	01259	62451	16
45	10 10 0	1 50 0	9.37600	9.92737	9.38853	10.61137	10.01263	10.62400	15
46	9 52	50 8	37652	92734	38918	61082	01266	62348	14
47	9 44	50 16	37703	92731	38972	61028	01269	62297	13
48	9 36	50 24	37753	92728	39027	60973	01272	62245	12
49	9 28	50 32	37806	92725	39082	60918	01275	62194	11
50	10 9 20	1 50 40	9.37832	9.92722	9.39136	10.60864	10.01278	10.62142	10
51	9 12	50 48	37885	92719	39190	60810	01281	62091	9
52	9 4	50 56	37960	92715	39245	60755	01283	62040	8
53	8 56	51 4	38011	92712	39299	60701	01286	61989	7
54	8 48	51 12	38062	92709	39353	60647	01291	61938	6
55	10 8 40	1 51 20	9.38113	9.92706	9.39407	10.60593	10.01294	10.61887	5
56	8 32	51 28	38164	92703	39461	60539	01297	61836	4
57	8 24	51 36	38215	92700	39515	60485	01300	61785	3
58	8 16	51 44	38266	92697	39569	60431	01303	61734	2
59	8 8	51 52	38317	92694	39623	60377	01306	61683	1
60	8 0	52 0	38368	92690	39677	60323	01310	61632	0
M	Hour. M.	Hour. M.	Co-sine.	Sine	Co-tang.	Tangent.	Co-secant.	Secant.	M

103 Degs.

Degs. 76.

TABLE XXVII

Log. Sines, Tangents and Secants.

11 Degs.

Deg. 185.

M	Hour. M.	Hour. M.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant
0	10 8 0	1 52 0	9.38368	9.98690	9.39677	10.60323	10.01310	10.61633
1	7 52	52 8	38418	98687	39731	60269	01313	61582
2	7 44	52 16	38469	98684	39785	60215	01316	61531
3	7 36	52 24	38519	98681	39838	60162	01319	61481
4	7 28	52 32	38570	98678	39892	60108	01322	61430
5	10 7 20	1 52 40	9.38630	9.98675	9.39945	10.60055	10.01325	10.61386
6	7 12	52 48	38670	98671	39999	60001	01329	61336
7	7 4	52 56	38721	98668	40052	59948	01332	61279
8	6 56	53 4	38771	98665	40105	59894	01335	61229
9	6 48	53 12	38821	98662	40159	59841	01338	61179
10	10 6 40	1 53 20	9.38871	9.98659	9.40212	10.59788	10.01341	10.61129
11	6 32	53 28	38921	98656	40266	59734	01344	61079
12	6 24	53 36	38971	98652	40319	59681	01348	61029
13	6 16	53 44	39021	98649	40372	59628	01351	60979
14	6 8	53 52	39071	98646	40425	59575	01354	60929
15	10 6 0	1 54 0	9.39121	9.98643	9.40478	10.59522	10.01357	10.60879
16	5 52	54 8	39170	98640	40531	59469	01360	60830
17	5 44	54 16	39220	98636	40584	59416	01364	60780
18	5 36	54 24	39270	98633	40636	59364	01367	60730
19	5 28	54 32	39319	98630	40689	59311	01370	60681
20	10 5 20	1 54 40	9.39369	9.98627	9.40743	10.59258	10.01373	10.60631
21	5 12	54 48	39418	98623	40798	59208	01377	60582
22	5 4	54 56	39467	98620	40847	59153	01380	60533
23	4 56	55 4	39517	98617	40900	59100	01383	60483
24	4 48	55 12	39566	98614	40953	59048	01386	60434
25	10 4 40	1 55 20	9.39615	9.98610	9.41002	10.58996	10.01390	10.60385
26	4 32	55 28	39664	98607	41057	58943	01393	60336
27	4 24	55 36	39713	98604	41109	58891	01396	60287
28	4 16	55 44	39762	98601	41161	58839	01399	60238
29	4 8	55 52	39811	98597	41214	58786	01403	60189
30	10 4 0	1 56 0	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140
31	3 52	56 8	39909	98591	41318	58682	01409	60091
32	3 44	56 16	39958	98588	41370	58630	01412	60042
33	3 36	56 24	40006	98584	41422	58578	01416	59994
34	3 28	56 32	40055	98581	41474	58526	01419	59945
35	10 3 20	1 56 40	9.40103	9.98578	9.41525	10.58474	10.01422	10.59897
36	3 12	56 48	40152	98574	41578	58422	01425	59848
37	3 4	56 56	40200	98571	41629	58371	01429	59800
38	2 56	57 4	40249	98568	41681	58319	01432	59751
39	2 48	57 12	40297	98565	41733	58267	01435	59703
40	10 2 40	1 57 20	9.40346	9.98561	9.41784	10.58216	10.01439	10.59654
41	2 32	57 28	40394	98558	41836	58164	01442	59606
42	2 24	57 36	40442	98555	41887	58113	01445	59558
43	2 16	57 44	40490	98551	41939	58061	01449	59510
44	2 8	57 52	40538	98548	41990	58010	01452	59462
45	10 2 0	1 58 0	9.40586	9.98545	9.42041	10.57959	10.01455	10.59414
46	1 52	58 8	40634	98542	42093	57907	01459	59366
47	1 44	58 16	40682	98539	42144	57856	01462	59318
48	1 36	58 24	40730	98535	42195	57805	01465	59270
49	1 28	58 32	40778	98531	42246	57754	01469	59222
50	10 1 20	1 58 40	9.40825	9.98528	9.42297	10.57703	10.01472	10.59175
51	1 12	58 48	40873	98525	42348	57652	01475	59127
52	1 4	58 56	40921	98521	42399	57601	01479	59079
53	0 56	59 4	40968	98518	42450	57550	01482	59032
54	0 48	59 12	41016	98515	42501	57499	01485	58984
55	10 0 40	1 59 20	9.41063	9.98511	9.42552	10.57448	10.01488	10.58937
56	0 32	59 28	41111	98508	42603	57397	01491	58889
57	0 24	59 36	41158	98505	42653	57347	01495	58841
58	0 16	59 44	41205	98501	42704	57296	01499	58793
59	0 8	59 52	41252	98498	42755	57245	01502	58745
60	0 0	2 0 0	41300	98494	42805	57193	01505	58700
M	Hour. M.	Hour. M.	Co-sine	Sine	Co-tang.	Tangent	Co-secant	Secant

104 Degs.

Deg. 75.

TABLE XXVII.
Log. Sines, Tangents and Secants.

199

15 Degs.

Degs. 164.

M	Hour. M.	Hour. M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 0 0	2 0 0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	9.59 52	0 8	41347	98491	42856	57144	01509	58653	59
2	59 44	0 16	41394	98484	42906	57094	01512	58606	58
3	59 36	0 24	41441	98477	42957	57043	01516	58559	57
4	59 28	0 32	41488	98471	43007	56993	01519	58512	56
5	9.59 20	2 0 40	9.41535	9.98477	9.43057	10.56943	10.01523	10.58465	55
6	59 12	0 48	41582	98471	43108	56892	01526	58418	54
7	59 4	0 56	41629	98464	43158	56842	01529	58372	53
8	58 56	1 4	41676	98457	43208	56792	01533	58325	52
9	58 48	1 12	41722	98451	43258	56742	01536	58278	51
10	9.58 40	2 1 20	9.41768	9.98460	9.43308	10.56692	10.01537	10.58232	50
11	58 32	1 28	41815	98457	43358	56642	01543	58185	49
12	58 24	1 36	41861	98453	43408	56592	01547	58139	48
13	58 16	1 44	41908	98450	43458	56542	01550	58092	47
14	58 8	1 52	41954	98447	43508	56492	01553	58046	46
15	9.58 0	2 2 0	9.42001	9.98447	9.43558	10.56442	10.01557	10.57999	45
16	57 52	2 8	42047	98447	43607	56393	01560	57952	44
17	57 44	2 16	42093	98436	43657	56343	01564	57907	43
18	57 36	2 24	42139	98433	43707	56293	01567	57860	42
19	57 28	2 32	42186	98429	43756	56244	01571	57814	41
20	9.57 20	2 2 40	9.42278	9.98422	9.43806	10.56194	10.01574	10.57768	40
21	57 12	2 48	42278	98422	43856	56145	01578	57722	39
22	57 4	2 56	42324	98419	43905	56095	01581	57676	38
23	56 56	3 4	42370	98415	43954	56046	01585	57630	37
24	56 48	3 12	42416	98412	44003	55996	01588	57584	36
25	9.56 40	3 3 20	9.42461	9.98409	9.44053	10.55947	10.01591	10.57539	35
26	56 32	3 28	42507	98405	44102	55896	01595	57493	34
27	56 24	3 36	42553	98402	44151	55849	01598	57447	33
28	56 16	3 44	42599	98398	44201	55799	01602	57401	32
29	56 8	3 52	42644	98395	44250	55750	01605	57356	31
30	9.56 0	2 4 0	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	55 52	4 8	42735	98388	44348	55652	01612	57265	29
32	55 44	4 16	42781	98384	44397	55603	01616	57219	28
33	55 36	4 24	42826	98381	44446	55554	01619	57174	27
34	55 28	4 32	42872	98377	44495	55505	01623	57128	26
35	9.55 20	2 4 40	9.42917	9.98373	9.44544	10.55456	10.01627	10.57083	25
36	55 12	4 48	42962	98370	44592	55408	01630	57038	24
37	55 4	4 56	43008	98366	44641	55359	01634	56992	23
38	54 56	5 4	43053	98363	44690	55310	01637	56947	22
39	54 48	5 12	43098	98359	44738	55262	01641	56902	21
40	9.54 40	2 5 20	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	54 32	5 28	43189	98352	44836	55164	01648	56811	19
42	54 24	5 36	43233	98349	44884	55116	01651	56767	18
43	54 16	5 44	43278	98346	44933	55067	01655	56721	17
44	54 8	5 52	43323	98342	44981	55019	01658	56677	16
45	9.54 0	3 6 0	9.43367	9.98339	9.45029	10.54971	10.01662	10.56632	15
46	53 52	6 8	43412	98334	45078	54922	01666	56588	14
47	53 44	6 16	43457	98331	45126	54873	01669	56544	13
48	53 36	6 24	43502	98327	45174	54824	01673	56500	12
49	53 28	6 32	43546	98324	45223	54775	01676	56456	11
50	9.53 20	3 6 40	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	53 12	6 48	43586	98317	45271	54681	01683	56365	9
52	53 4	6 56	43630	98313	45320	54633	01687	56320	8
53	52 56	7 4	43674	98309	45369	54585	01691	56276	7
54	52 48	7 12	43719	98306	45418	54537	01694	56232	6
55	9.52 40	3 7 20	9.43813	9.98302	9.45513	10.54489	10.01698	10.56187	5
56	52 32	7 28	43857	98299	45562	54441	01701	56143	4
57	52 24	7 36	43901	98295	45611	54394	01705	56099	3
58	52 16	7 44	43946	98291	45660	54346	01709	56054	2
59	52 8	7 52	43990	98288	45709	54298	01712	56010	1
60	52 0	8 0	44034	98284	45758	54250	01716	55966	0

165 Degs.

Degs. 74.

TABLE XXVII.
Logs. Sines, Tangents and Secants.

16 Degs.											Degs. 163.	
M	Hour	Min.	Hour	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M	Hour	Min.
0	9	52	0	9.44034	9.98204	9.43750	10.54250	10.01716	10.55566	60		
1		51	52	44078	98281	43797	54203	01719	55522	59		
2		51	44	44122	98277	43845	54156	01723	55476	58		
3		51	36	44166	98273	43892	54109	01727	55430	57		
4		51	28	44210	98270	43940	54060	01730	55384	56		
5	9	51	20	9.44253	9.98266	9.43987	10.54013	10.01734	10.55747	55		
6		51	12	44297	98262	46035	53965	01738	55703	54		
7		51	4	44341	98259	46082	53918	01741	55659	53		
8		50	56	44385	98255	46130	53870	01745	55615	52		
9		50	48	44429	98251	46177	53823	01749	55572	51		
10	9	50	40	9.44472	9.98248	9.46224	10.53776	10.01752	10.55626	50		
11		50	32	44516	98244	46271	53729	01756	55484	49		
12		50	24	44559	98240	46319	53681	01760	55441	48		
13		50	16	44602	98237	46366	53634	01763	55398	47		
14		50	8	44646	98233	46413	53587	01767	55354	46		
15	9	50	0	9.44689	9.98229	9.46460	10.53540	10.01771	10.55311	45		
16		49	52	44733	98226	46507	53493	01774	55267	44		
17		49	44	44776	98222	46554	53446	01778	55224	43		
18		49	36	44819	98218	46601	53399	01782	55181	42		
19		49	28	44862	98215	46648	53352	01785	55138	41		
20	9	49	20	9.44905	9.98211	9.46694	10.53306	10.01789	10.55095	40		
21		49	12	44948	98207	46741	53259	01793	55052	39		
22		49	4	44992	98204	46788	53212	01796	55008	38		
23		49	56	45035	98200	46835	53165	01800	54965	37		
24		48	48	45077	98196	46881	53119	01804	54923	36		
25	9	48	40	9.45120	9.98192	9.46928	10.53072	10.01808	10.54880	35		
26		48	32	45163	98189	46975	53025	01811	54837	34		
27		48	24	45206	98185	47021	52979	01815	54794	33		
28		48	16	45249	98181	47068	52932	01819	54751	32		
29		48	8	45292	98177	47114	52886	01823	54708	31		
30	9	48	0	9.45334	9.98174	9.47160	10.52840	10.01826	10.54666	30		
31		47	52	45377	98170	47207	52793	01830	54623	29		
32		47	44	45419	98166	47253	52747	01834	54581	28		
33		47	36	45462	98162	47299	52701	01838	54538	27		
34		47	28	45504	98159	47346	52654	01841	54496	26		
35	9	47	20	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25		
36		47	12	45589	98151	47438	52562	01849	54411	24		
37		47	4	45632	98147	47484	52516	01853	54368	23		
38		46	56	45674	98144	47530	52470	01856	54326	22		
39		46	48	45716	98140	47576	52424	01860	54284	21		
40	9	46	40	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20		
41		46	32	45801	98132	47668	52332	01868	54199	19		
42		46	24	45843	98129	47714	52286	01871	54157	18		
43		46	16	45885	98125	47760	52240	01875	54115	17		
44		46	8	45927	98121	47806	52194	01879	54073	16		
45	9	46	0	9.45969	9.98117	9.47852	10.52148	10.01883	10.54031	15		
46		45	52	45911	98113	47897	52103	01887	53989	14		
47		45	44	46053	98110	47943	52057	01890	53947	13		
48		45	36	46095	98106	47989	52011	01894	53905	12		
49		45	28	46136	98102	48035	51965	01898	53861	11		
50	9	45	20	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10		
51		45	12	46220	98094	48126	51874	01906	53780	9		
52		45	4	46262	98090	48171	51829	01910	53738	8		
53		44	56	46303	98087	48217	51783	01913	53697	7		
54		44	48	46345	98083	48262	51738	01917	53655	6		
55	9	44	40	9.46386	9.98079	9.48307	10.51693	10.01921	10.53614	5		
56		44	32	46428	98075	48353	51647	01925	53572	4		
57		44	24	46469	98071	48398	51602	01929	53531	3		
58		44	16	46511	98067	48443	51557	01933	53489	2		
59		44	8	46552	98063	48489	51511	01937	53448	1		
60		44	0	46594	98060	48534	51466	01940	53406	0		
M	Hour	Min.	Hour	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M	Hour	Min.
106 Degs.											Degs. 73.	



TABLE XXVII.
Log. Sines, Tangents and Secants.

201

17 Degs.

Degs. 162.

SI	Hour.A.M.	Hour.P.M.	Sine.	Co-sine.	Tangent	Co-tang.	Secant.	Co-secant.	M
0	9 44 0	2 16 0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53406	60
1	43 52	16 8	46635	98056	48579	51421	01944	53365	59
2	43 44	16 16	46676	98052	48624	51376	01948	53324	58
3	43 36	16 24	46717	98048	48669	51331	01952	53283	57
4	43 28	16 32	46758	98044	48714	51286	01956	53242	56
5	9 43 20	2 16 40	9.46 100	9.98040	9.48759	10.51241	10.01960	10.53200	55
6	43 12	16 48	46841	98036	48804	51196	01964	53159	54
7	43 4	16 56	46882	98032	48849	51151	01968	53118	53
8	42 56	17 4	46923	98029	48894	51106	01971	53077	52
9	42 48	17 12	46964	98025	48939	51061	01975	53036	51
10	9 42 40	2 17 20	9.47005	9.98021	9.48984	10.51016	10.01979	10.52995	50
11	42 32	17 28	47045	98017	49029	50971	01983	52953	49
12	42 24	17 36	47086	98013	49073	50927	01987	52914	48
13	42 16	17 44	47127	98009	49118	50882	01991	52873	47
14	42 8	17 52	47168	98005	49163	50837	01995	52832	46
15	9 42 0	2 18 0	9.47209	9.98001	9.49267	10.50793	10.01999	10.52791	45
16	41 52	18 8	47249	97997	49312	50748	02003	52751	44
17	41 44	18 16	47290	97993	49356	50704	02007	52710	43
18	41 36	18 24	47330	97989	49401	50659	02011	52670	42
19	41 28	18 32	47371	97985	49445	50615	02014	52629	41
20	9 41 20	2 18 40	9.47411	9.97982	9.49430	10.50570	10.02018	10.52589	40
21	41 12	18 48	47452	97979	49474	50526	02022	52548	39
22	41 4	18 56	47492	97974	49519	50481	02026	52507	38
23	40 56	19 4	47533	97970	49563	50437	02030	52467	37
24	40 48	19 12	47573	97966	49607	50393	02034	52427	36
25	9 40 40	2 19 20	9.47613	9.97962	9.49632	10.50346	10.02038	10.52387	35
26	40 32	19 28	47654	97958	49646	50304	02042	52346	34
27	40 24	19 36	47694	97954	49740	50260	02046	52306	33
28	40 16	19 44	47734	97950	49784	50216	02050	52266	32
29	40 8	19 52	47774	97946	49828	50172	02054	52226	31
30	9 40 0	2 20 0	9.47814	9.97942	9.49872	10.50123	10.02058	10.52186	30
31	39 52	20 8	47854	97938	49916	50084	02062	52146	29
32	39 44	20 16	47894	97934	49960	50040	02066	52106	28
33	39 36	20 24	47934	97930	50004	49996	02070	52066	27
34	39 28	20 32	47974	97926	50048	49952	02074	52026	26
35	9 39 20	2 20 40	9.48014	9.97922	9.50092	10.49906	10.02078	10.51936	25
36	39 12	20 48	48054	97918	50136	49864	02082	51946	24
37	39 4	20 56	48094	97914	50180	49820	02086	51906	23
38	38 56	21 4	48133	97910	50223	49777	02090	51867	22
39	38 48	21 12	48173	97906	50267	49733	02094	51827	21
40	9 38 40	2 21 20	9.48213	9.97902	9.50311	10.49659	10.02098	10.51787	20
41	38 32	21 28	48252	97898	50355	49645	02102	51748	19
42	38 24	21 36	48292	97894	50398	49602	02106	51708	18
43	38 16	21 44	48332	97890	50442	49558	02110	51668	17
44	38 8	21 52	48371	97886	50485	49513	02114	51629	16
45	9 38 0	2 22 0	9.48411	9.97882	9.50529	10.49471	10.02118	10.51539	15
46	37 52	22 8	48450	97878	50572	49427	02122	51500	14
47	37 44	22 16	48490	97874	50616	49384	02126	51460	13
48	37 36	22 24	48529	97870	50659	49341	02130	51421	12
49	37 28	22 32	48569	97866	50703	49297	02134	51382	11
50	9 37 20	2 22 40	9.48607	9.97861	9.50746	10.49254	10.02138	10.51293	10
51	37 12	22 48	48647	97857	50789	49211	02142	51353	9
52	37 4	22 56	48686	97853	50833	49167	02146	51314	8
53	36 56	23 4	48725	97849	50876	49124	02150	51275	7
54	36 48	23 12	48764	97845	50919	49081	02154	51236	6
55	9 36 40	2 23 20	9.48803	9.97841	9.50962	10.49033	10.02158	10.51197	5
56	36 32	23 28	48842	97837	50905	48995	02162	51158	4
57	36 24	23 36	48881	97833	50948	48952	02166	51119	3
58	36 16	23 44	48920	97829	50992	48908	02170	51080	2
59	36 8	23 52	48959	97825	51035	48865	02174	51041	1
60	36 0	24 0	48998	97821	51078	48822	02178	51002	0
M	Hour.A.M.	Hour.P.M.	Co-sine.	Sine.	Cotang.	Tangent.	Co-secant.	Secant.	M

107 Degs.

B b

Degs. 72.

18 Degr.										De
M	Hour. m.	Hour. m.	Sine.	Co-sine.	Tangent	Co-tang.	Secant.	Co-secant		
0	9 36 0	2 24 0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51000		
1	35 52	24 8	49037	97817	51221	48779	02183	50996		
2	35 44	24 16	49076	97812	51264	48736	02188	50992		
3	35 36	24 24	49115	97808	51306	48694	02192	50988		
4	35 28	24 32	49153	97804	51349	48651	02196	50984		
5	9 35 20	2 24 40	9.49192	9.97800	9.51392	10.48608	10.02200	10.50880		
6	35 12	24 48	49231	97796	51435	48565	02204	50769		
7	35 4	24 56	49269	97792	51478	48522	02208	50753		
8	34 56	25 4	49308	97788	51520	48480	02212	50697		
9	34 48	25 12	49347	97784	51563	48437	02216	50653		
10	9 34 40	2 25 20	9.49385	9.97779	9.51606	10.48394	10.02221	10.50613		
11	34 32	25 28	49424	97775	51648	48352	02225	50576		
12	34 24	25 36	49462	97771	51691	48309	02229	50538		
13	34 16	25 44	49500	97767	51734	48266	02233	50500		
14	34 8	25 52	49539	97763	51776	48224	02237	50461		
15	9 34 0	2 26 0	9.4957	9.97759	9.51819	10.48181	10.02241	10.50433		
16	33 52	26 8	49615	97754	51861	48139	02246	50385		
17	33 44	26 16	49654	97750	51903	48097	02250	50346		
18	33 36	26 24	49692	97746	51946	48054	02254	50308		
19	33 28	26 32	49730	97742	51988	48012	02258	50270		
20	9 33 20	2 26 40	9.49768	9.97735	9.52031	10.47969	10.02262	10.50232		
21	33 12	26 48	49806	97734	52073	47927	02266	50194		
22	33 4	26 56	49844	97729	52115	47885	02271	50156		
23	32 56	27 4	49882	97725	52157	47843	02275	50118		
24	32 48	27 12	49920	97721	52200	47800	02279	50080		
25	9 32 40	2 27 20	9.49958	9.97717	9.52242	10.47758	10.02283	10.50042		
26	32 32	27 28	49996	97713	52284	47716	02287	50004		
27	32 24	27 36	50034	97708	52326	47674	02292	49966		
28	32 16	27 44	50072	97704	52368	47632	02296			
29	32 8	27 52	50110	97700	52410	47590	02300	49890		
30	9 32 0	2 28 0	9.50148	9.97696	9.52462	10.47548	10.02304	10.49852		
31	31 52	28 8	50185	97691	52494	47506	02309	49815		
32	31 44	28 16	50223	97687	52536	47464	02313	49777		
33	31 36	28 24	50261	97683	52578	47422	02317	49739		
34	31 28	28 32	50298	97679	52620	47380	02321	49702		
35	9 31 20	2 28 40	9.50336	9.97674	9.52661	10.47339	10.02326	10.49664		
36	31 12	28 48	50374	97670	52703	47297	02330	49626		
37	31 4	28 56	50411	97666	52745	47255	02334	49589		
38	30 56	29 4	50449	97662	52787	47213	02338	49551		
39	30 48	29 12	50486	97657	52829	47171	02343	49514		
40	9 30 40	2 29 20	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477		
41	30 32	29 28	50561	97649	52912	47088	02351	49439		
42	30 24	29 36	50598	97645	52953	47047	02355			
43	30 16	29 44	50635	97640	52995	47005	02360	49363		
44	30 8	29 52	50673	97636	53037	46963	02364	49327		
45	9 30 0	2 30 0	9.50710	9.97632		10.46922		10.49290		
46	29 52	30 8	50747	97628	53120	46880		49253		
47	29 44	30 16	50784	97623	53161	46839	02377	49216		
48	29 36	30 24	50821	97619		46798	02381	49179		
49	29 28	30 32	50858	97615	53244	46756	02385	49142		
50	9 29 20	2 30 40	9.50896	9.97610	9.53285	10.46715		10.49104		
51	29 12	30 48	50933	97606	53327	46673	02394	49067		
52	29 4	30 56	50970	97602	53368	46632	02398	49030		
53	28 56	31 4	51007	97597	53409	46591	02403	48993		
54	28 48	31 12	51043	97593	53450	46550	02407	48957		
55	9 28 40	2 31 20	9.51080	9.97589	9.53492		10.02411	10.48920		
56	28 32	31 28	51117	97584	53533	46467	02416	48883		
57	28 24	31 36	51154	97580	53574	46426	02420	48846		
58	28 16	31 44	51191	97576	53615	46385	02424	48809		
59	28 8	31 52	51227	97571	53656	46344	02429	48773		
60	28 0	32 0	51264	97567	53697	46303	02433	48736		
M	Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.		De

TABLE XXVII.
Long. Sines, Tangents and Secants.

203

19 Degs.

Degs. 160.

M	Hour. m.	Hour. s.	Sine	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 28 0	2 32 0	9 51364	9 97567	9 53697	10 46303	10 02433	10 48736	60
1	27 52	32 8	51301	97563	53738	46262	02437	48699	59
2	27 44	32 16	51338	97558	53779	46221	02442	48662	58
3	27 36	32 24	51374	97554	53820	46180	02446	48626	57
4	27 28	32 32	51411	97550	53861	46139	02450	48589	56
5	9 27 20	2 32 40	9 51447	9 97545	9 53902	10 46098	10 02455	10 48553	55
6	27 12	32 48	51484	97541	53943	46057	02459	48516	54
7	27 4	32 56	51520	97536	53984	46016	02464	48480	53
8	26 56	33 4	51557	97532	54025	45975	02468	48443	52
9	26 48	33 12	51593	97528	54065	45935	02472	48407	51
10	9 26 40	2 33 20	9 51629	9 97523	9 54106	10 45894	10 02477	10 48371	50
11	26 32	33 28	51666	97519	54147	45853	02481	48334	49
12	26 24	33 36	51702	97515	54187	45813	02485	48298	48
13	26 16	33 44	51738	97510	54228	45772	02490	48262	47
14	26 8	33 52	51774	97506	54269	45731	02494	48226	46
15	9 26 0	2 34 0	9 51811	9 97501	9 54309	10 45691	10 02499	10 48189	45
16	25 52	34 8	51847	97497	54350	45650	02503	48153	44
17	25 44	34 16	51883	97492	54390	45610	02508	48117	43
18	25 36	34 24	51919	97488	54431	45569	02512	48081	42
19	25 28	34 32	51955	97484	54471	45529	02516	48045	41
20	9 25 20	2 34 40	9 51991	9 97479	9 54512	10 45488	10 02521	10 48009	40
21	25 12	34 48	52027	97475	54552	45448	02525	47973	39
22	25 4	34 56	52063	97470	54593	45407	02530	47937	38
23	24 56	35 4	52099	97466	54633	45367	02534	47901	37
24	24 48	35 12	52135	97461	54673	45327	02539	47865	36
25	9 24 40	2 35 20	9 52171	9 97457	9 54714	10 45286	10 02543	10 47829	35
26	24 32	35 28	52207	97453	54754	45246	02547	47793	34
27	24 24	35 36	52242	97448	54794	45206	02552	47758	33
28	24 16	35 44	52278	97444	54835	45165	02556	47722	32
29	24 8	35 52	52314	97439	54875	45125	02561	47686	31
30	9 24 0	2 36 0	9 52350	9 97435	9 54915	10 45085	10 02565	10 47650	30
31	23 52	36 8	52386	97430	54955	45045	02570	47615	29
32	23 44	36 16	52421	97426	54995	45005	02574	47579	28
33	23 36	36 24	52456	97421	55035	44965	02579	47544	27
34	23 28	36 32	52492	97417	55075	44925	02583	47508	26
35	9 23 20	2 36 40	9 52527	9 97412	9 55115	10 44885	10 02588	10 47473	25
36	23 12	36 48	52563	97408	55155	44845	02592	47437	24
37	23 4	36 56	52598	97403	55195	44805	02597	47402	23
38	22 56	37 4	52634	97399	55235	44765	02601	47366	22
39	22 48	37 12	52669	97394	55275	44725	02606	47331	21
40	9 22 40	2 37 20	9 52705	9 97390	9 55315	10 44685	10 02610	10 47295	20
41	22 32	37 28	52740	97385	55355	44645	02615	47260	19
42	22 24	37 36	52775	97381	55395	44605	02619	47225	18
43	22 16	37 44	52811	97376	55434	44566	02624	47189	17
44	22 8	37 52	52846	97372	55474	44526	02628	47154	16
45	9 22 0	2 38 0	9 52881	9 97367	9 55514	10 44486	10 02633	10 47119	15
46	21 52	38 8	52916	97363	55554	44446	02637	47084	14
47	21 44	38 16	52951	97358	55593	44407	02642	47049	13
48	21 36	38 24	52986	97353	55633	44367	02647	47014	12
49	21 28	38 32	53021	97349	55673	44327	02651	46979	11
50	9 21 20	2 38 40	9 53056	9 97344	9 55712	10 44288	10 02656	10 46944	10
51	21 12	38 48	53092	97340	55752	44248	02660	46908	9
52	21 4	38 56	53126	97335	55791	44209	02665	46874	8
53	20 56	39 4	53161	97331	55831	44169	02669	46839	7
54	20 48	39 12	53196	97326	55870	44130	02674	46804	6
55	9 20 40	2 39 20	9 53231	9 97322	9 55910	10 44090	10 02678	10 46769	5
56	20 32	39 28	53266	97317	55949	44051	02683	46734	4
57	20 24	39 36	53301	97312	55989	44011	02688	46699	3
58	20 16	39 44	53336	97308	56028	43972	02692	46664	2
59	20 8	39 52	53370	97303	56067	43933	02697	46630	1
60	20 0	40 0	53405	97299	56107	43893	02701	46595	0
M	Hour. m.	Hour. s.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

109 Degs.

Degs. 10.

TABLE XXVII.
Log. Sines, Tangents and Secants.

20 Degs.				Degs. 159							
M	Hour	M	Hour	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M	
0	9 20	0	2 40	9 53405	9 97299	9 56107	10 43 93	10 02701	10 46695	60	
1	19 52	40	8	53440	97294	56146	43554	02706	46660	59	
2	19 44	40	16	53475	97289	56185	43615	02711	46625	58	
3	19 36	40	24	53509	97285	56224	43776	02715	46491	57	
4	19 28	40	32	53544	97280	56263	43776	02720	46456	56	
5	19 20	40	40	9 53578	9 97276	9 56303	10 43697	10 02724	10 46422	55	
6	19 12	40	48	53613	97271	56342	43658	02729	46387	54	
7	19 4	40	56	53647	97266	56381	43619	02734	46353	53	
8	18 56	41	4	53682	97262	56420	43580	02739	46318	52	
9	18 48	41	12	53716	97257	56459	43541	02743	46284	51	
10	18 40	41	20	9 53751	9 97253	9 56498	10 43502	10 02748	10 46249	50	
11	18 32	41	28	53785	97249	56537	43463	02752	46215	49	
12	18 24	41	36	53819	97245	56576	43424	02757	46181	48	
13	18 16	41	44	53854	97240	56615	43385	02762	46146	47	
14	18 8	41	52	53888	97236	56654	43346	02766	46112	46	
15	18 0	42	0	9 53922	9 97232	9 56693	10 43307	10 02771	10 46078	45	
16	17 52	42	8	53957	97227	56732	43268	02776	46043	44	
17	17 44	42	16	53991	97223	56771	43229	02780	46009	43	
18	17 36	42	24	54025	97219	56810	43190	02785	45975	42	
19	17 28	42	32	54059	97215	56849	43151	02790	45941	41	
20	17 20	42	40	9 54093	9 97211	9 56887	10 43113	10 02794	10 45907	40	
21	17 12	42	48	54127	97207	56926	43074	02799	45873	39	
22	17 4	42	56	54161	97196	56965	43035	02804	45839	38	
23	16 56	43	4	54195	97192	57004	42996	02808	45805	37	
24	16 48	43	12	54229	97187	57042	42957	02813	45771	36	
25	16 40	43	20	9 54263	9 97183	9 57081	10 42919	10 02818	10 45737	35	
26	16 32	43	28	54297	97178	57120	42880	02822	45703	34	
27	16 24	43	36	54331	97173	57158	42842	02827	45669	33	
28	16 16	43	44	54365	97168	57197	42803	02832	45635	32	
29	16 8	43	52	54399	97163	57235	42765	02837	45601	31	
30	16 0	44	0	9 54433	9 97159	9 57274	10 42726	10 02841	10 45567	30	
31	15 52	44	8	54466	97154	57312	42687	02846	45534	29	
32	15 44	44	16	54500	97149	57351	42649	02851	45500	28	
33	15 36	44	24	54534	97145	57389	42611	02855	45466	27	
34	15 28	44	32	54567	97140	57428	42572	02860	45433	26	
35	15 20	44	40	9 54601	9 97136	9 57466	10 42534	10 02865	10 45399	25	
36	15 12	44	48	54635	97131	57504	42496	02870	45365	24	
37	15 4	44	56	54668	97127	57543	42457	02874	45332	23	
38	14 56	45	4	54702	97122	57581	42419	02879	45298	22	
39	14 48	45	12	54735	97118	57619	42381	02884	45265	21	
40	14 40	45	20	9 54769	9 97114	9 57658	10 42342	10 02889	10 45231	20	
41	14 32	45	28	54802	97109	57696	42304	02893	45198	19	
42	14 24	45	36	54836	97105	57734	42266	02898	45164	18	
43	14 16	45	44	54869	97101	57772	42228	02903	45131	17	
44	14 8	45	52	54903	97096	57810	42190	02908	45097	16	
45	14 0	46	0	9 54936	9 97092	9 57849	10 42151	10 02913	10 45064	15	
46	13 52	46	8	54969	97088	57887	42113	02917	45031	14	
47	13 44	46	16	55003	97083	57925	42075	02922	44997	13	
48	13 36	46	24	55036	97079	57963	42037	02927	44964	12	
49	13 28	46	32	55069	97075	58001	41999	02932	44931	11	
50	13 20	46	40	9 55102	9 97071	9 58039	10 41961	10 02937	10 44897	10	
51	13 12	46	48	55136	97067	58077	41923	02941	44864	9	
52	13 4	46	56	55169	97063	58115	41885	02946	44831	8	
53	12 56	47	4	55202	97059	58153	41847	02951	44798	7	
54	12 48	47	12	55235	97054	58191	41809	02956	44765	6	
55	12 40	47	20	9 55268	9 97050	9 58229	10 41771	10 02961	10 44732	5	
56	12 32	47	28	55301	97046	58267	41733	02965	44699	4	
57	12 24	47	36	55334	97042	58304	41696	02970	44666	3	
58	12 16	47	44	55367	97038	58342	41658	02975	44633	2	
59	12 8	47	52	55400	97033	58380	41620	02980	44600	1	
60	12 0	48	0	55433	97029	58418	41582	02985	44567	0	
M	Hour	M	Hour	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M	

TABLE XXVII.

205

Log. Sines, Tangents and Secants.

21 Degs.

Degs. 120.

M	Hours. m.	Hours. m.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 12 0	2 48 0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	11 52	48 8	55406	97010	58455	41545	02990	44561	59
2	11 44	48 16	55499	97005	58493	41507	02995	44501	58
3	11 36	48 24	55532	97001	58531	41469	02997	44468	57
4	11 28	48 32	55564	96996	58569	41431	03004	44436	56
5	9 11 20	2 48 40	9.55597	9.96991	9.58606	10.41394	10.03019	10.44403	55
6	11 12	48 48	55630	96986	58644	41356	03014	44370	54
7	11 4	48 56	55663	96981	58681	41319	03019	44337	53
8	10 56	49 4	55695	96976	58719	41281	03014	44305	52
9	10 48	49 12	55728	96971	58757	41243	03029	44272	51
10	9 10 40	2 49 20	9.55761	9.96966	9.58794	10.41206	10.03034	10.44239	50
11	10 32	49 28	55793	96962	58832	41168	03038	44207	49
12	10 24	49 36	55826	96957	58869	41131	03043	44174	48
13	10 16	49 44	55858	96952	58907	41093	03048	44142	47
14	10 8	49 52	55891	96947	58944	41056	03053	44109	46
15	9 10 0	2 50 0	9.55923	9.96942	9.58981	10.41019	10.03058	10.44077	45
16	9 52	50 8	55956	96937	59019	40981	03063	44044	44
17	9 44	50 16	55988	96932	59056	40944	03068	44012	43
18	9 36	50 24	56021	96927	59094	40906	03073	43979	42
19	9 28	50 32	56053	96922	59131	40869	03078	43947	41
20	9 9 20	2 50 40	9.56088	9.96917	9.59168	10.40832	10.03083	10.43910	40
21	9 12	50 48	56118	96912	59205	40795	03088	43882	39
22	9 4	50 56	56150	96907	59243	40757	03093	43850	38
23	8 56	51 4	56182	96903	59280	40720	03097	43818	37
24	8 48	51 12	56215	96898	59317	40683	03102	43785	36
25	9 8 40	2 51 20	9.56247	9.96893	9.59354	10.40646	10.03107	10.43763	35
26	8 32	51 28	56279	96888	59391	40609	03112	43721	34
27	8 24	51 36	56311	96883	59429	40571	03117	43689	33
28	8 16	51 44	56343	96878	59466	40534	03122	43657	32
29	8 8	51 52	56375	96873	59503	40497	03127	43625	31
30	9 8 0	2 52 0	9.56408	9.96866	9.59540	10.40460	10.03132	10.43592	30
31	7 52	52 8	56440	96863	59577	40423	03137	43560	29
32	7 44	52 16	56472	96858	59614	40386	03142	43528	28
33	7 36	52 24	56504	96853	59651	40349	03147	43496	27
34	7 28	52 32	56536	96848	59688	40312	03152	43464	26
35	9 7 20	2 52 40	9.56568	9.96843	9.59725	10.40275	10.03157	10.43432	25
36	7 12	52 48	56599	96838	59762	40238	03162	43400	24
37	7 4	52 56	56631	96833	59799	40201	03167	43369	23
38	6 56	53 4	56663	96828	59835	40165	03172	43337	22
39	6 48	53 12	56695	96823	59872	40128	03177	43305	21
40	9 6 40	2 53 20	9.56727	9.96818	9.59969	10.40091	10.03162	10.43273	20
41	6 32	53 28	56759	96813	59946	40054	03167	43241	19
42	6 24	53 36	56790	96808	59983	40017	03192	43210	18
43	6 16	53 44	56822	96803	60019	39981	03197	43178	17
44	6 8	53 52	56854	96798	60056	39944	03202	43146	16
45	9 6 0	2 54 0	9.56886	9.96793	9.60093	10.39907	10.03207	10.43114	15
46	5 52	54 8	56917	96788	60130	39870	03212	43083	14
47	5 44	54 16	56949	96783	60166	39834	03217	43051	13
48	5 36	54 24	56980	96778	60203	39797	03222	43020	12
49	5 28	54 32	57012	96772	60240	39760	03228	42988	11
50	9 5 20	2 54 40	9.57044	9.96767	9.60276	10.39724	10.03233	10.42956	10
51	5 12	54 48	57075	96762	60313	39687	03238	42925	9
52	5 4	54 56	57107	96757	60349	39651	03243	42893	8
53	4 56	55 4	57138	96752	60386	39614	03248	42862	7
54	4 48	55 12	57169	96747	60422	39578	03253	42831	6
55	9 4 40	2 55 20	9.57201	9.96742	9.60459	10.39541	10.03258	10.42799	5
56	4 32	55 28	57232	96737	60495	39505	03263	42768	4
57	4 24	55 36	57264	96732	60532	39468	03268	42736	3
58	4 16	55 44	57295	96727	60568	39432	03273	42705	2
59	4 8	55 52	57326	96722	60605	39395	03278	42674	1
60	4 0	56 0	57358	96717	60641	39359	03283	42643	0
M	Hours. m.	Hours. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

111 Degs.

Degs. 60.

TABLE XXVII.

Log. Sines, Tangents and Secants.

22 Degs.

Degs. 157

M	Hour A.M.	Hour P.M.	Sine	Co-sine	Tangent	Co-tang	Secant	Co-secant	M
0	9 4 0	2 56 0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
1	3 52	56 8	57389	96711	60677	39323	03289	42611	59
2	3 44	56 16	57420	96706	60714	39286	03294	42580	58
3	3 36	56 24	57451	96701	60750	39250	03299	42549	57
■	3 28	56 32	57482	96696	60786	39214	03304	42518	56
5	9 3 20	2 56 40	9.57514	9.96691	9.60823	10.39177	10.03309	10.42486	55
6	3 12	56 48	57545	96686	60859	39141	03314	42455	54
7	3 4	56 56	57576	96681	60895	39105	03319	42424	■
8	2 56	57 4	57607	96676	60931	39069	03324	42393	52
9	2 48	57 12	57638	96670	60967	39033	03330	■	51
10	9 2 40	2 57 20	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	2 32	57 28	57700	96660	61040	38960	03340	42300	49
12	2 24	57 36	57731	96655	61076	38924	03345	42269	48
■	2 16	57 44	57762	96650	61112	38888	03350	42238	47
14	2 8	57 52	57793	96645	61148	38852	03355	42207	46
15	9 2 0	2 58 0	9.57824	9.96640	9.61184	10.38816	10.03360	10.42176	45
16	1 52	58 8	57855	96634	61220	38780	03366	42145	44
17	1 44	58 16	57886	96629	61256	38744	03371	42115	■
18	1 36	58 24	57916	96624	61292	38708	03376	42084	42
19	1 28	58 32	57947	96619	61328	38672	03381	42053	41
20	9 1 20	2 58 40	9.57978	9.96614	9.61364	10.38636	10.03386	10.42022	40
21	1 12	58 48	58008	96608	61400	38600	03392	41992	39
22	1 4	58 56	58039	96603	61436	38564	03397	41961	38
23	0 56	59 4	58070	96598	61472	38528	03402	41930	37
■	0 48	59 12	58101	96593	61508	38492	03407	41899	36
25	9 0 40	2 59 20	9.58131	9.96588	9.61544	10.38456	10.03412	10.41869	35
26	0 32	59 28	58162	96582	61579	38421	03418	41838	34
27	0 24	59 36	58192	96577	61615	38385	03423	41808	33
28	0 16	59 44	58223	96572	61651	38349	03428	41777	32
29	0 8	59 52	58253	96567	61687	38313	03433	41747	31
30	9 0 0	3 0 0	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	30
31	0 59 52	0 8	58314	96556	61758	38242	03444	41686	29
32	59 44	0 16	58345	96551	61794	38206	03449	41655	28
33	59 36	0 24	58375	96546	61830	38170	03454	41625	27
34	59 28	0 32	58406	96541	61865	38135	03459	41594	26
35	8 59 20	3 0 40	9.58436	9.96535	9.61901	10.38099	10.03465	10.41564	25
36	59 12	0 48	58467	96530	61936	38064	03470	41533	24
37	59 4	0 56	58497	96525	61972	38028	03475	41503	23
38	58 56	1 4	58527	96520	62008	37992	03480	41473	22
39	58 48	1 12	58557	96514	62043	37957	03486	41443	21
40	8 58 40	3 1 20	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	58 32	1 28	58618	96504	62114	37886	■	■	19
42	58 24	1 36	58648	96498	62150	37850	■	41352	18
43	58 16	1 44	58678	96493	62185	37815	03507	41322	17
44	58 8	1 52	58709	96488	62221	37779	03512	41291	16
45	8 58 0	3 2 0	9.58739	9.96483	9.62256	10.37744	10.03517	10.41261	15
46	57 52	2 8	58769	96477	62292	37708	03523	41231	14
47	57 44	2 16	58799	96472	62327	37673	■	41201	13
48	57 36	2 24	58829	96467	62362	37638	03533	41171	■
■	57 28	2 32	58859	96461	62398	37602	03539	41141	11
50	8 57 20	3 2 40	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	57 12	2 48	58919	96451	62468	37532	03549	41081	9
52	57 4	2 56	58949	96445	62504	37496	■	41051	8
53	56 56	3 4	58979	96440	62539	37461	03560	41021	7
54	56 48	3 12	59009	96435	62574	37426	03565	40991	6
55	8 56 40	3 3 20	9.59039	9.96429	9.62609	10.37391	10.03571	10.40961	5
56	56 32	3 28	59069	96424	62645	37355	03576	40931	4
57	56 24	3 36	59098	96419	62680	37320	03581	■	3
58	56 16	■ 44	59128	96413	62715	37285	03587	40872	2
59	56 8	3 52	59158	■	62750	37250	03592	40842	1
60	56 0	4 0	59188	96403	62785	37215	03597	40812	0
M	Hour P.M.	Hour A.M.	Co-sine	Sine	Co-tang.	Tangent	Co-secant	Secant	M

112 Degs.

Degs. 57

TABLE XXVII.

207

Log. Sines, Tangents and Secants.

23 Degs.

Degs. 156.

M	Hour A. M.	Hour P. M.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M
0	8 56 0	3 4 0	9 59188	9.96403	9.62785	10 37215	10 03597	10 40812	60
1	55 52	4 8	59218	96397	62820	37180	03603	40782	59
2	55 44	4 16	59247	96392	62855	37145	03608	40753	58
3	55 36	4 24	59277	96387	62890	37110	03613	40723	57
4	55 28	4 32	59307		62926	37074	03619	40693	56
5	8 55 20	3 4 40	9 59336	9 96376	9.62961	10 37039	10 03624	10 40664	55
6	55 12	4 48	59366	96370	62996	37004	03630	40634	54
7	55 4	4 56	59396	96365	63031	36969	03635	40604	53
8	54 56	5 4	59425	96360	63066	36934	03640	40575	52
9	54 48	5 12	59455	96354	63101	36899	03646	40545	51
10	8 54 40	3 5 20	9 59484	9 96349	9.63135	10 36865	10 03651	10 40516	50
11	54 32	5 28	59514	96343	63170	36830	03657	40486	49
12	54 24	5 36	59543	96338	63205	36795	03662	40457	48
13	54 16	5 44	59573	96333	63240	36760	03667	40427	47
14	54 8	5 52	59602	96327	63275	36725	03673	40398	46
15	8 54 0	3 6 0	9 59632	9.96322	9.63310	10 36690	10 03678	10 40368	45
16	53 52	6 8	59661	96316	63345	36655	03684	40339	44
17	53 44	6 16	59690	96311	63379	36621	03689	40310	43
18	53 36	6 24	59720	96305	63414	36586	03695	40280	42
19	53 28	6 32	59749	96300	63449	36551	03700	40251	41
20	8 53 20	3 6 40	9 59778	9 96294	9.63484	10 36516	10 03706	10 40222	
21	53 12	6 48	59808	96289	63519	36481	03711	40192	39
22	53 4	6 56	59837	96284	63553	36447	03716	40163	38
23	52 56	7 4	59866	96278	63588	36412	03722	40134	37
24	52 48	7 12	59895	96273	63623	36377	03727	40105	36
25	8 52 40	3 7 20	9 59924	9.96267	9 63657	10 36343	10 03733	10 40076	35
26	52 32	7 28	59954	96262	63692	36308	03738	40046	34
27	52 24	7 36	59983	96256	63726	36274	03744	40017	33
28	52 16	7 44	60012	96251	63761	36239	03749	39988	32
29	52 8	7 52	60041	96245	63796	36204	03755	39959	31
30	8 52 0	3 8 0	9 60070	9 96240	9 63830	10 36170	10 03760	10 39930	30
31	51 52	8 8	60099	96234	63865	36135	03766	39901	29
32	51 44	8 16	60128	96229	63899	36101	03771	39872	28
33	51 36	8 24	60157	96223	63934	36066	03777	39843	27
34	51 28	8 32	60186	96218	63968	36032	03782	39814	26
35	8 51 20	3 8 40	9 60215	9 96212	9 64003	10 35997	10 03788	10 39785	25
36	51 12	8 48	60244	96207	64037	35963	03793	39756	
37	51 4	8 56	60273	96201	64072	35928	03799	39727	23
38	50 56	9 4	60302	96196	64106	35894	03804	39698	22
39	50 48	9 12	60331	96190	64140	35860	03810	39669	21
40	8 50 40	3 9 20	9 60359	9.96185	9.64175	10 35825	10 03816	10 39641	20
41	50 32	9 28	60388	96179	64209	35791	03821	39612	19
42	50 24	9 36	60417	96174	64243	35757	03826	39583	18
43	50 16	9 44	60446	96168	64278	35722	03832	39554	17
44	50 8	9 52	60474	96162		35688	03838	39526	
45	8 50 0	3 10 0	9 60503	9.96157	9 64346	10 35664	10 03843	10 39497	16
46	49 52	10 8	60532	96151	64381	35630	03849	39468	14
47	49 44	10 16	60561	96146	64415	35595	03854	39439	13
48	49 36	10 24	60589	96140	64449	35561	03860	39411	12
49	49 28	10 32	60618	96135	64483	35527	03865	39382	11
50	8 49 20	3 10 40	9 60646	9 96129	9.64517	10 35483	10 03871	10 39354	10
51	49 12	10 48	60675	96123	64552	35448	03877	39325	9
52	49 4	10 56	60704	96118	64586	35414	03882	39296	8
53	48 56	11 4	60732	96112	64620	35380	03888	39268	7
54	48 48	11 12	60761	96107	64654	35346	03893	39239	
55	8 48 40	3 11 20	9 60789	9 96101	9.64688	10 35312	10 03899	10 39211	5
56	48 32	11 28	60818	96095	64722	35278	03905	39182	4
57	48 24	11 36	60846	96090	64756	35244	03910	39154	3
58	48 16	11 44	60875	96084	64790	35210	03916		2
59	48 8	11 52	60903	96079	64824	35176	03921		1
60	48 0	12 0		96073	64858	35142	03927	39069	0
M	Hour P. M.	Hour A. M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

113 Degs.

Degs. 64.

TABLE XXVII.

Log. Sines, Tangents and Secants.

24 Degs.				Degs. 155.						
M	Hour M.	Hour M.	Sine.	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M	
0	8 48 0	3 12 0	9.60931	9.96073	9.6445	10.35142	10.03927	10.39069	59	
1	47 52	12 3	60960	96067	64292	35108	03933	39041	59	
2	47 44	12 16	60988	96062	64226	35074	03938	39012	58	
3	47 36	12 24	61016	96056	64260	35040	03944	38984	57	
4	47 28	12 32	61045	96050	64294	35006	03950	38955	56	
5	8 47 20	3 12 40	9.61073	9.96045	9.65028	10.34972	10.03955	10.38927	55	
6	47 12	12 48	61101	96039	65062	34932	03961	38899	54	
7	47 4	12 56	61129	96034	65096	34901	03966	38871	53	
8	46 56	13 4	61158	96028	65130	34870	03972	38842	52	
9	46 48	13 12	61186	96022	65164	34836	03978	38814	51	
10	8 46 40	3 13 20	9.61214	9.96017	9.65197	10.34803	10.03983	10.38736	50	
11	46 32	13 28	61242	96011	65231	34769	03989	38758	49	
12	46 24	13 36	61270	96005	65265	34735	03995	38730	48	
13	46 16	13 44	61298	96000	65299	34701	04000	38702	47	
14	46 8	13 52	61326	95994	65333	34667	04006	38674	46	
15	8 46 0	3 14 0	9.61354	9.95988	9.65366	10.34634	10.04012	10.38646	45	
16	45 52	14 8	61382	95982	65400	34600	04018	38618	44	
17	45 44	14 16	61411	95977	65434	34566	04023	38589	43	
18	45 36	14 24	61438	95971	65467	34533	04029	38562	42	
19	45 28	14 32	61466	95965	65501	34500	04035	38534	41	
20	8 45 20	3 14 40	9.61494	9.95960	9.65535	10.34465	10.04040	10.38546	40	
21	45 12	14 48	61522	95954	65568	34432	04046	38518	39	
22	45 4	14 56	61550	95948	65602	34398	04052	38490	38	
23	44 56	15 4	61578	95942	65636	34364	04058	38462	37	
24	44 48	15 12	61606	95937	65669	34331	04063	38434	36	
25	8 44 40	3 15 20	9.61634	9.95931	9.65703	10.34297	10.04069	10.38366	35	
26	44 32	15 28	61662	95925	65736	34264	04075	38336	34	
27	44 24	15 36	61689	95920	65770	34230	04080	38311	33	
28	44 16	15 44	61717	95914	65803	34197	04086	38283	32	
29	44 8	15 52	61745	95908	65837	34163	04092	38255	31	
30	8 44 0	3 16 0	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30	
31	43 52	16 8	61800	95897	65904	34096	04103	38200	29	
32	43 44	16 16	61828	95891	65937	34063	04109	38172	28	
33	43 36	16 24	61856	95885	65971	34029	04115	38144	27	
34	43 28	16 32	61883	95879	66004	33996	04121	38117	26	
35	8 43 20	3 16 40	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089	25	
36	43 12	16 48	61939	95868	66071	33929	04132	38061	24	
37	43 4	16 56	61966	95862	66104	33896	04138	38034	23	
38	42 56	17 4	61994	95856	66138	33862	04144	38006	22	
39	42 48	17 12	62021	95850	66171	33829	04150	37979	21	
40	8 42 40	3 17 20	9.62049	9.95844	9.66204	10.33796	10.04156	10.37951	20	
41	42 32	17 28	62076	95839	66238	33762	04161	37924	19	
42	42 24	17 36	62104	95833	66271	33729	04167	37896	18	
43	42 16	17 44	62131	95827	66304	33696	04173	37869	17	
44	42 8	17 52	62159	95821	66337	33663	04179	37841	16	
45	8 42 0	3 18 0	9.62186	9.95815	9.66371	10.33629	10.04183	10.37814	15	
46	41 52	18 8	62214	95810	66404	33596	04190	37786	14	
47	41 44	18 16	62241	95804	66437	33563	04196	37759	13	
48	41 36	18 24	62268	95798	66470	33530	04202	37732	12	
49	41 28	18 32	62296	95792	66503	33497	04208	37704	11	
50	8 41 20	3 18 40	9.62323	9.95796	9.66537	10.33463	10.04214	10.37677	10	
51	41 12	18 48	62350	95780	66570	33430	04220	37650	9	
52	41 4	18 56	62377	95775	66603	33397	04225	37623	8	
53	40 56	19 4	62405	95769	66636	33364	04231	37595	7	
54	40 48	19 12	62432	95763	66669	33331	04237	37568	6	
55	8 40 40	3 19 20	9.62459	9.95777	9.66702	10.33293	10.04243	10.37541	5	
56	40 32	19 28	62486	95751	66735	33260	04249	37514	4	
57	40 24	19 36	62513	95745	66768	33227	04255	37487	3	
58	40 16	19 44	62541	95739	66801	33194	04261	37459	2	
59	40 8	19 52	62568	95733	66834	33161	04267	37432	1	
60	40 0	20 0	62595	95728	66867	33128	04272	37405	0	
M	Hour M.	Hour M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M	

114 Degs.

Degs. 60

TABLE XXVII.
Log. Sines, Tangents and Secants.

209

Degs.		Degs. 154.							
Hour. m.	Hour. m.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M	
8 40 0	3 20 0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	60	
39 52	20 8	62622	95722	66900	33100	04278	37378	59	
39 44	20 16	62649	95716	66933	33067	04284	37351	58	
39 36	20 24	62676	95710	66966	33034	04290	37324	57	
39 28	20 32	62703	95704	66999	33001	04296	37297	56	
8 39 20	3 20 40	9.62750	9.95698	9.67032	10.32968	10.04302	10.37270	55	
39 12	20 48	62737	95692	67065	32935	04308	37243	54	
39 4	20 56	62784	95686	67098	32902	04314	37216	53	
39 56	21 4	62811	95680	67131	32869	04320	37189	52	
38 15	21 12	62838	95674	67163	32837	04326	37162	51	
8 38 40	3 21 20	9.62865	9.95664	9.67196	10.32804	10.04332	10.37135	50	
38 32	21 28	62892	95663	67229	32771	04337	37108	49	
38 24	21 36	62918	95657	67262	32738	04343	37082	48	
38 16	21 44	62945	95651	67295	32705	04349	37055	47	
38 8	21 52	62972	95645	67327	32673	04355	37028	46	
8 37 0	3 22 0	9.62999	9.95639	9.67360	10.32640	10.04361	10.37001	45	
37 52	22 8	63026	95633	67393	32607	04367	36974	44	
37 44	22 16	63053	95627	67426	32574	04373	36948	43	
37 36	22 24	63079	95621	67458	32542	04379	36921	42	
37 28	22 32	63106	95615	67491	32509	04385	36894	41	
8 37 20	3 22 40	9.63133	9.95609	9.67524	10.32476	10.04391	10.36867	40	
37 12	22 48	63159	95603	67556	32444	04397	36841	39	
37 4	22 56	63186	95597	67589	32411	04403	36814	38	
36 56	23 4	63213	95591	67622	32378	04409	36787	37	
36 48	23 12	63239	95585	67654	32346	04415	36761	36	
8 36 40	3 23 20	9.63266	9.95579	9.67687	10.32313	10.04421	10.36734	35	
36 32	23 28	63292	95573	67719	32311	04427	36708	34	
36 24	23 36	63319	95567	67752	32278	04433	36681	33	
36 16	23 44	63345	95561	67785	32246	04439	36655	32	
36 8	23 52	63372	95555	67817	32213	04445	36628	31	
8 36 0	3 24 0	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30	
35 52	24 8	63425	95543	67882	32118	04457	36575	29	
35 44	24 16	63451	95537	67915	32085	04463	36549	28	
35 36	24 24	63478	95531	67947	32053	04469	36522	27	
35 28	24 32	63504	95525	67980	32020	04475	36496	26	
8 35 20	3 24 40	9.63531	9.95519	9.68012	10.31987	10.04461	10.36479	25	
35 12	24 48	63557	95513	68044	31956	04467	36453	24	
35 4	24 56	63583	95507	68077	31923	04473	36427	23	
34 56	25 4	63610	95500	68109	31891	04479	36400	22	
34 48	25 12	63636	95494	68142	31858	04485	36374	21	
8 34 40	3 25 20	9.63662	9.95488	9.68174	10.31826	10.04481	10.36351	20	
34 32	25 28	63689	95482	68206	31794	04487	36325	19	
34 24	25 36	63715	95476	68239	31761	04493	36299	18	
34 16	25 44	63741	95470	68271	31729	04499	36273	17	
34 8	25 52	63767	95464	68303	31697	04505	36247	16	
8 34 0	3 26 0	9.63794	9.95458	9.68336	10.31664	10.04502	10.36206	15	
33 52	26 8	63820	95452	68368	31632	04508	36180	14	
33 44	26 16	63846	95446	68400	31600	04514	36154	13	
33 36	26 24	63872	95440	68432	31568	04520	36128	12	
33 28	26 32	63898	95434	68465	31535	04526	36102	11	
8 33 20	3 26 40	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10	
33 12	26 48	63950	95421	68529	31471	04579	36050	9	
33 4	26 56	63976	95415	68561	31439	04585	36024	8	
32 56	27 4	64002	95409	68593	31407	04591	35998	7	
32 48	27 12	64028	95403		31374	04597	35972	6	
8 32 40	3 27 20	9.64054	9.95397	9.68658	10.31343	10.04603	10.35946	5	
32 32	27 28	64080	95391	68690	31310	04609	35920	4	
32 24	27 36	64106		68722	31278	04615	35894	3	
32 16	27 44	64132	95378	68754	31246	04621	35868	2	
32 8	27 52	64158	95372	68786	31214	04627	35842	1	
32 0	28 0	64184	95366	68818	31182	04633	35816	0	
Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M	

Degs.

C c

Degs. 64

TABLE XXVII. Log. Sines, Tangents and Secants.

25 Degs.										Degs. 153	
M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.			
0	8 32 0	3 28 0	9 64184	9 95366	9 69018	10 31182	10 04634	10 35816	6		
1	31 52	28 8	64210	95360	68850	31150	04640	35790	5		
2	31 44	28 16	64236	95354	68882	31118		35764	5		
3	31 36	28 24	64262	95348	68914	31086	04652	35738	5		
4	31 28	28 32	64288	95341	68946	31054	04659	35712	5		
5	8 31 20	3 28 40	9 64313	9 95335	9 68978	10 31022	10 04665	10 35687	5		
6	31 12	28 48	64339	95329	68910	30990	04671	35661	5		
7	31 4	28 56	64365	95323	69042	30958	04677	35635	5		
8	30 56	29 4	64391	95317	69074	30926	04683	35609	5		
9	30 48	29 12	64417	95310	69106	30894	04690	35583	5		
10	8 30 40	3 29 20	9 64442	9 95304	9 69138	10 30862	10 04696	10 35558	5		
11	30 32	29 28	64468	95298	69170	30830	04702	35532	4		
12	30 24	29 36	64494	95292	69202	30798	04708	35506	4		
13	30 16	29 44	64519	95286	69234	30766	04714	35481	4		
14	30 8	29 52	64545	95279	69266	30734	04721	35455	4		
15	8 30 0	3 30 0	9 64571	9 95273	9 69298	10 30702	10 04727	10 35429	4		
16	29 52	30 8	64596	95267	69329	30671	04733	35404	4		
17	29 44	30 16	64622	95261	69361	30639	04739	35378	4		
18	29 36	30 24	64647	95254	69393	30607	04746	35353	4		
19	29 28	30 32	64673	95248	69425	30575	04752	35327	4		
20	8 29 20	3 30 40	9 64698	9 95242	9 69457	10 30543	10 04758	10 35302	4		
21	29 12	30 48	64724	95236	69488	30512	04764	35276			
22	29 4	30 56	64749	95229	69520	30480	04771	35251	3		
23	28 56	31 4	64775	95223	69552	30448	04777	35225	3		
24	28 48	31 12	64800	95217	69584	30416	04783	35200	3		
25	8 28 40	3 31 20	9 64826	9 95211	9 69615	10 30385	10 04789	10 35174	3		
26	28 32	31 28	64851	95204	69647	30353	04796	35148	3		
27	28 24	31 36	64877	95198	69679	30321	04802	35123	3		
28	28 16	31 44	64902	95192	69710	30290	04808	35098			
29	28 8	31 52	64927	95185	69742	30258	04815	35073	3		
30	8 28 0	3 32 0	9 64953	9 95179	9 69774	10 30226	10 04821	10 35047	3		
31	27 52	32 8	64978	95173	69805	30195	04827	35022	2		
32	27 44	32 16	65003	95167	69837	30163	04833	34997	2		
33	27 36	32 24	65029	95160	69868	30132	04840	34971	2		
34	27 28	32 32	65054	95154	69900	30100	04846	34946	2		
35	8 27 20	3 32 40	9 65079	9 95148	9 69932	10 30068	10 04852				
36	27 12	32 48	65104	95141	69963	30037	04859	34896	2		
37	27 4	32 56	65130	95135	69995	30005	04865	34870	2		
38	26 56	33 4	65155	95129	70026	29974	04871	34845	2		
39	26 48	33 12	65180	95123	70058	29942	04878	34820	2		
40	8 26 40	3 33 20	9 65205	9 95116	9 70089	10 29911	10 04884	10 34795	2		
41	26 32	33 28	65230	95110	70121	29879	04890	34770	19		
42	26 24	33 36	65255	95103	70152	29848	04897	34745	18		
43	26 16	33 44	65281	95097	70184	29816	04903	34719	17		
44	26 8	33 52	65306	95090	70215	29785	04910	34694	16		
45	8 26 0	3 34 0	9 65331	9 95084	9 70247	10 29753	10 04916	10 34669	15		
46	25 52	34 8	65356	95078	70278	29722	04922	34644	14		
47	25 44	34 16	65381	95071	70309	29691	04929		13		
48	25 36	34 24	65406	95065	70341	29659	04936	34594	12		
49	25 28	34 32	65431	95059	70372	29628	04941		11		
50	8 25 20	3 34 40	9 65456	9 95052	9 70404	10 29596	10 04948	10 34544	10		
51	25 12	34 48	65481	95046	70435	29565	04954	34519	9		
52	25 4	34 56	65506	95039	70466	29534	04961	34494	8		
53	24 56	35 4	65531	95033	70498	29502	04967	34469	7		
54	24 48	35 12	65556	95027	70529	29471	04973	34444	6		
55	8 24 40	3 35 20	9 65580	9 95020	9 70560	10 29440	10 04980	10 34420	5		
56	24 32	35 28	65605	95014	70592	29408		34395	4		
57	24 24	35 36	65630	95007	70623	29377	04993	34370	3		
58	24 16	35 44	65655	95001	70654	29346	04999	34345	2		
59	24 8	35 52	65680	94995	70685	29315	05006	34320	1		
60	24 0	36 0	65705	94988	70717	29283	05012	34295	0		
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M		
115 Degs.										Degs. 62	

TABLE XXVII.

211

Log. Sines, Tangents and Secants.

27 Degs.

Degs. 152.

M	Hour. m.	Hour. m.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 24 0	3 36 0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34293	60
1	23 52	36 8	65729	94982	70748	29262	05018	34271	59
2	23 44	36 16	65754	94975	70779	29221	05025	34246	58
3	23 36	36 24	65779	94969	70810	29190	05031	34221	57
4	23 28	36 32	65804	94962	70841	29159	05038	34196	56
5	8 23 30	3 36 40	9.65828	9.94956	9.70873	10.29127	10.05044	10.34172	55
6	23 12	36 48	65833	94949	70904	29096	05051	34147	54
7	23 4	36 56	65878	94943	70935	29055	05057	34122	53
8	22 56	37 4	65902	94936	70966	29034	05064	34098	52
9	22 48	37 12	65927	94930	70997	29003	05070	34073	51
10	8 22 40	3 37 20	9.65952	9.94923	9.71024	10.28972	10.05077	10.34048	50
11	22 32	37 28	65976	94917	71059	28941	05083	34024	49
12	22 24	37 36	66001	94911	71090	28910	05089	34000	48
13	22 16	37 44	66025	94904	71121	28879	05096	33975	47
14	22 8	37 52	66050	94898	71153	28847	05102	33950	46
15	8 22 0	3 38 0	9.66074	9.94891	9.71184	10.28816	10.05109	10.33925	45
16	21 52	38 8	66099	94885	71215	28785	05115	33901	44
17	21 44	38 16	66124	94878	71246	28754	05122	33876	43
18	21 36	38 24	66149	94871	71277	28723	05129	33852	42
19	21 28	38 32	66173	94865	71308	28692	05135	33827	41
20	8 21 20	3 38 40	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	21 12	38 48	66221	94852	71370	28630	05148	33779	39
22	21 4	38 56	66246	94845	71401	28599	05155	33754	38
23	20 56	39 4	66270	94839	71431	28569	05161	33730	37
24	20 48	39 12	66295	94832	71462	28538	05168	33705	36
25	8 20 40	3 39 20	9.66319	9.94826	9.71493	10.28507	10.05174	10.33681	35
26	20 32	39 28	66343	94819	71524	28476	05181	33657	34
27	20 24	39 36	66368	94813	71555	28445	05187	33632	33
28	20 16	39 44	66392	94806	71586	28414	05194	33608	32
29	20 8	39 52	66416	94799	71617	28383	05201	33584	31
30	8 20 0	3 40 0	9.66441	9.94793	9.71643	10.28352	10.05207	10.33559	30
31	19 52	40 8	66465	94786	71679	28321	05214	33535	29
32	19 44	40 16	66489	94780	71709	28291	05220	33511	28
33	19 36	40 24	66513	94773	71740	28260	05227	33487	27
34	19 28	40 32	66537	94767	71771	28229	05233	33463	26
35	8 19 20	3 40 40	9.66563	9.94760	9.71802	10.28198	10.05240	10.33438	25
36	19 12	40 48	66586	94753	71833	28167	05247	33414	24
37	19 4	40 56	66610	94747	71863	28137	05253	33390	23
38	18 56	41 4	66634	94740	71894	28106	05260	33366	22
39	18 48	41 12	66658	94734	71925	28075	05266	33342	21
40	8 18 40	3 41 20	9.66682	9.94727	9.71936	10.28045	10.05274	10.33316	20
41	18 32	41 28	66706	94720	71966	28014	05280	33294	19
42	18 24	41 36	66731	94714	72017	27983	05286	33269	18
43	18 16	41 44	66755	94707	72048	27952	05293	33245	17
44	18 8	41 52	66779	94700	72078	27922	05299	33221	16
45	8 18 0	3 42 0	9.66803	9.94694	9.72109	10.27891	10.05306	10.33197	15
46	17 52	42 8	66827	94687	72140	27860	05313	33173	14
47	17 44	42 16	66851	94680	72170	27830	05320	33149	13
48	17 36	42 24	66875	94674	72201	27799	05326	33125	12
49	17 28	42 32	66899	94667	72231	27769	05333	33101	11
50	8 17 20	3 42 40	9.66922	9.94660	9.72262	10.27738	10.05340	10.33078	10
51	17 12	42 48	66946	94654	72293	27707	05346	33054	9
52	17 4	42 56	66970	94647	72323	27677	05353	33030	8
53	16 56	43 4	66994	94640	72354	27646	05360	33006	7
54	16 48	43 12	67018	94634	72384	27616	05366	32982	6
55	8 16 40	3 43 20	9.67043	9.94627	9.72415	10.27585	10.05373	10.32958	5
56	16 32	43 28	67066	94620	72445	27555	05380	32934	4
57	16 24	43 36	67090	94614	72476	27524	05386	32910	3
58	16 16	43 44	67113	94607	72506	27494	05393	32887	2
59	16 8	43 52	67137	94600	72537	27463	05400	32863	1
60	16 0	44 0	67161	94593	72567	27433	05407	32839	0
M	Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

117 Degs.

Degs. 62.

Log. Sines, Tangents and Secants.

28 Degs.

Degs. 151.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 16 0	3 44 0	9.67161	9.94593	9.72567	10.27433	10.05407	10.32839	60
1	15 52	44 8	67185	94587	72598	27402	05413	32815	59
2	15 44	44 16	67208	94580	72628	27372	05420	32792	58
3	15 36	44 24	67232	94573	72659	27341	05427	32768	57
4	15 28	44 32	67256	94567	72689	27311	05433	32744	56
5	8 15 20	3 44 40	9.67280	9.94560	9.72720	10.27280	10.05440	10.32720	55
6	15 12	44 48	67303	94553	72750	27250	05447	32697	54
7	15 4	44 56	67327	94546	72780	27220	05454	32673	53
8	14 56	45 4	67350	94540	72811	27189	05460	32650	52
9	14 48	45 12	67374	94533	72841	27159	05467	32626	51
10	8 14 40	3 45 20	9.67398	9.94526	9.72872	10.27128	10.05474	10.32602	50
11	14 32	45 28	67421	94519	72902	27098	05481	32579	49
12	14 24	45 36	67445	94513	72932	27068	05487	32555	48
13	14 16	45 44	67468	94506	72963	27037	05494	32532	47
14	14 8	45 52	67492	94499	72993	27007	05501	32508	46
15	8 14 0	3 46 0	9.67515	9.94492	9.73023	10.26977	10.05508	10.32485	45
16	13 52	46 8	67539	94485	73054	26946	05515	32461	44
17	13 44	46 16	67562	94479	73084	26916	05521	32438	43
18	13 36	46 24	67586	94472	73114	26886	05528	32414	42
19	13 28	46 32	67609	94465	73144	26856	05535	32391	41
20	8 13 20	3 46 40	9.67633	9.94458	9.73175	10.26825	10.05542	10.32367	40
21	13 12	46 48	67656	94451	73205	26795	05549	32344	39
22	13 4	46 56	67680	94445	73235	26765	05555	32320	38
23	12 56	47 4	67703	94438	73265	26735	05562	32297	37
24	12 18	47 12	67726	94431	73295	26705	05569	32274	36
25	8 12 40	3 47 20	9.67750	9.94424	9.73326	10.26674	10.05576	10.32250	35
26	12 32	47 28	67773	94417	73356	26644	05583	32227	34
27	12 24	47 36	67796	94410	73386	26614	05590	32204	33
28	12 16	47 44	67820	94404	73416	26584	05596	32180	32
29	12 8	47 52	67843	94397	73446	26554	05603	32157	31
30	8 12 0	3 48 0	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
31	11 52	48 8	67890	94383	73507	26493	05617	32110	29
32	11 44	48 16	67913	94376	73537	26463	05624	32087	28
33	11 36	48 24	67936	94369	73567	26433	05631	32064	27
34	11 28	48 32	67959	94362	73597	26403	05638	32041	26
35	8 11 20	3 48 40	9.67982	9.94355	9.73627	10.26373	10.05645	10.32018	25
36	11 12	48 48	68006	94349	73657	26343	05651	31994	24
37	11 4	48 56	68029	94342	73687	26313	05658	31971	23
38	10 56	49 4	68052	94335	73717	26283	05665	31948	22
39	10 48	49 12	68075	94328	73747	26253	05672	31925	21
40	8 10 40	3 49 20	9.68098	9.94321	9.73777	10.26223	10.05679	10.31902	20
41	10 32	49 28	68121	94314	73807	26193	05686	31879	19
42	10 24	49 36	68144	94307	73837	26163	05693	31856	18
43	10 16	49 44	68167	94300	73867	26133	05700	31833	17
44	10 8	49 52	68190	94293	73897	26103	05707	31810	16
45	8 10 0	3 50 0	9.68213	9.94286	9.73927	10.26073	10.05714	10.31787	15
46	9 52	50 8	68237	94279	73957	26043	05721	31763	14
47	9 44	50 16	68260	94273	73987	26013	05727	31740	13
48	9 36	50 24	68283	94266	74017	25983	05734	31717	12
49	9 28	50 32	68305	94259	74047	25953	05741	31695	11
50	8 9 20	3 50 40	9.68328	9.94252	9.74077	10.25923	10.05748	10.31672	10
51	9 12	50 48	68351	94245	74107	25893	05755	31649	9
52	9 4	50 56	68374	94238	74137	25863	05762	31626	8
53	8 56	51 4	68397	94231	74166	25834	05769	31603	7
54	8 48	51 12	68420	94224	74196	25804	05776	31580	6
55	8 8 40	3 51 20	9.68443	9.94217	9.74226	10.25774	10.05783	10.31557	5
56	8 32	51 28	68466	94210	74256	25744	05790	31534	4
57	8 24	51 36	68489	94203	74286	25714	05797	31511	3
58	8 16	51 44	68512	94196	74316	25684	05804	31488	2
59	8 8	51 52	68534	94189	74345	25655	05811	31466	1
60	8 0	52 0	68557	94182	74375	25625	05818	31443	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

118 Degs.

Degs. 61.

TABLE XXVII.

219

Log. Sines, Tangents and Secants.

29 Deg.											Deg. 150.		
M	Hour	Min.	Hour	Min.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M		
0	8	8	0	3	52	0	9.68657	9.94182	9.74375	10.25625	10.05818	10.31443	60
1		7	52		52	8	68680	94175	74405	25695	05825	31420	59
2		7	44		52	16	68603	94168	74435	25665	05832	31397	58
3		7	36		52	24	68625	94161	74465	25635	05839	31374	57
4		7	28		52	32	68648	94154	74494	25606	05846	31352	56
5	8	7	20	3	52	40	9.68671	9.94147		10.25476	10.05853	10.31329	55
6		7	12		52	48	68694	94140	74554	25446	05860	31306	54
7		7	4		52	56	68716	94133	74583	25417	05867	31284	53
8		6	56		53	4	68739	94126	74613	25387	05874	31261	52
9		6	48		53	12	68762	94119	74643	25357	05881	31239	51
10	8	6	40	3	53	20	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11		6	32		53	28	68807	94105	74702	25298	05895	31193	49
12		6	24		53	36		94098	74732	25268	05902	31171	48
13		6	16		53	44	68852	94090	74762	25238	05910	31148	47
14		6	8		53	52	68875	94083	74791	25209	05917	31126	46
15	8	6	0	3	54	0	9.68897	9.94076	9.74821	10.25179	10.05924	10.31103	45
16		5	52		54	8	68920	94069	74851	25149	05931	31080	44
17		5	44		54	16	68942	94062	74880	25120	05938	31058	43
18		5	36		54	24		94055	74910	25090	05945	31035	42
19		5	28		54	32	68987	94048	74939	25061	05952	31013	41
20	8	5	20	3	54	40	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21		5	12		54	48	69032	94034	74998	25002	05966	30968	39
22		5	4		54	56	69055	94027	75028	24972	05973	30945	38
23		4	56		55	4	69077	94020	75058	24942	05980	30923	37
24		4	48		55	12	69100	94012	75087	24913	05988	30900	36
25	8	4	40	3	55	20	9.69122	9.94005	9.75117	10.24883	10.05995	10.30878	35
26		4	32		55	28	69144	93998	75146	24854	06002	30856	34
27		4	24		55	36	69167	93991	75176		06009	30833	33
28		4	16		55	44	69189	93984	75205	24795	06016	30811	32
29		4	8		55	52	69212	93977	75235	24765	06023	30788	31
30	8	4	0	3	56	0	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
31		3	52		56	8	69256	93963	75294	24706	06037	30744	29
32		3	44		56	16	69279	93955	75323	24677	06045	30721	28
		3	36		56	24	69301	93948	75353	24647	06052	30699	27
34		3	28		56	32	69323	93941	75382	24618	06059	30677	26
35	8	3	20	3	56	40	9.69345	9.93934	9.75411	10.24589	10.06066	10.30656	25
36		3	12		56	48	69368	93927	75441	24559	06073	30632	24
37		3	4		56	56	69390	93920	75470	24530	06080	30610	23
38		2	56		57	4	69412	93912	75500	24500	06088	30588	22
39		2	48		57	12	69434	93905	75529	24471	06095	30566	21
40	8	2	40	3	57	20	9.69456	9.93898	9.75558	10.24442	10.06102	10.30544	20
41		2	32		57	28	69479	93891	75588	24412	06109	30521	19
42		2	24		57	36	69501	93884	75617	24383	06116	30499	18
43		2	16		57	44	69523	93876	75647	24353	06124	30477	17
44		2	8		57	52	69545	93869	75676	24324	06131	30455	16
45	8	2	0	3	58	0	9.69567	9.93862	9.75705	10.24295	10.06138	10.30433	15
46		1	52		58	8	69589	93855	75735	24265	06145	30411	14
47		1	44		58	16	69611		75764	24236	06153	30389	13
48		1	36		58	24	69633	93840	75793	24207	06160	30367	12
49		1	28		58	32	69655	93833	75822	24178	06167	30345	11
50	8	1	20	3	58	40	9.69677	9.93826	9.75852	10.24148	10.06174	10.30323	10
51		1	12		58	48	69699	93819	75881	24119	06181	30301	9
52		1	4		58	56	69721	93811	75910	24090	06189	30279	8
53		0	56		59	4	69743	93804	75939	24061	06196	30257	7
54		0	48		59	12	69765	93797	75969	24031	06203	30235	6
55	8	0	40	3	59	20	9.69787	9.93789	9.75998	10.24002	10.06211	10.30213	5
56		0	32		59	28	69809	93782	76027	23973	06218	30191	4
57		0	24		59	36	69831	93775	76056	23944	06225	30169	3
58		0	16		59	44	69853	93768	76085	23914	06232	30147	2
59		0	8		59	52	69875	93760	76115	23885	06240	30125	1
60		0	0	4	0	0	69897	93753	76144	23856	06247	30103	0
M	Hour	Min.	Hour	Min.	Co-sine	Sine	Co-tang.	Tangent	Co-secant	Secant	M		
19 Deg.											Deg. 46		

19 Deco.

100

TABLE XXVII.

Log. Sines, Tangents and Secants.

30 Degs.

Degs. 140.

M	Hour A. M.	Hour P. M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 0 0	4 0 0	9 69897	9 93753	9 76144	10 23856	10 06247	10 30103	60
1	7 59 52	0 8	69911	93746	76173	23827	06254	30081	59
2	59 44	0 16	69941	93738	76202	23798	06262	30059	58
3	59 36	0 24	69963	93731	76231	23769	06269	30037	57
4	59 28	0 32	69984	93724	76261	23739	06276	30016	56
5	7 59 20	4 0 40	9 70006	9 93717	9 76290	10 23710	10 06283	10 29994	55
6	59 12	0 48	70028	93709	76319	23681	06291	29972	54
7	59 4	0 56	70050	93702	76348	23652	06298	29950	53
8	58 56	1 4	70072	93695	76377	23623	06306	29928	52
9	58 48	1 12	70093	93687	76406	23594	06313	29907	51
10	7 58 40	4 1 20	9 70115	9 93680	9 76435	10 23565	10 06320	10 29885	50
11	58 32	1 28	70137	93673	76464	23536	06327	29863	49
12	58 24	1 36	70169	93665	76493	23507	06335	29841	48
13	58 16	1 44	70180	93658	76522	23478	06342	29820	47
14	58 8	1 52	70202	93650	76551	23449	06350	29798	46
15	7 58 0	4 2 0	9 70224	9 93643	9 76580	10 23420	10 06357	10 29776	45
16	57 52	2 8	70246	93636	76609	23391	06364	29755	44
17	57 44	2 16	70267	93628	76639	23361	06372	29733	43
18	57 36	2 24	70288	93621	76668	23332	06379	29712	42
19	57 28	2 32	70310	93614	76697	23303	06386	29690	41
20	7 57 20	4 2 40	9 70332	9 93606	9 76725	10 23275	10 06394	10 29668	40
21	57 12	2 48	70353	93599	76754	23246	06401	29647	39
22	57 4	2 56	70375	93591	76783	23217	06409	29625	38
23	56 56	3 4	70396	93584	76812	23188	06416	29604	37
24	56 48	3 12	70418	93577	76841	23159	06423	29582	36
25	7 56 40	4 3 20	9 70439	9 93569	9 76870	10 23130	10 06431	10 29561	35
26	56 32	3 28	70461	93562	76899	23101	06438	29539	34
27	56 24	3 36	70482	93554	76928	23072	06446	29518	33
28	56 16	3 44	70504	93547	76957	23043	06453	29496	32
29	56 8	3 52	70525	93539	76986	23014	06461	29475	31
30	7 56 0	4 4 0	9 70547	9 93532	9 77015	10 22985	10 06468	10 29453	30
31	55 52	4 8	70568	93525	77044	22956	06475	29432	29
32	55 44	4 16	70590	93517	77073	22927	06483	29410	28
33	55 36	4 24	70611	93510	77101	22899	06490	29389	27
34	55 28	4 32	70633	93502	77130	22870	06498	29367	26
35	7 55 20	4 4 40	9 70654	9 93495	9 77159	10 22841	10 06505	10 29346	25
36	55 12	4 48	70675	93487	77188	22812	06513	29325	24
37	55 4	4 56	70697	93480	77217	22783	06520	29303	23
38	54 56	5 4	70718	93472	77246	22754	06528	29282	22
39	54 48	5 12	70739	93465	77274	22726	06535	29261	21
40	7 54 40	4 5 20	9 70761	9 93457	9 77303	10 22697	10 06543	10 29239	20
41	54 32	5 28	70782	93450	77332	22668	06550	29218	19
42	54 24	5 36	70803	93442	77361	22639	06558	29197	18
43	54 16	5 44	70824	93435	77390	22610	06565	29176	17
44	54 8	5 52	70846	93427	77418	22582	06573	29154	16
45	7 54 0	4 6 0	9 70867	9 93420	9 77447	10 22553	10 06580	10 29133	15
46	53 52	6 8	70888	93412	77476	22524	06588	29112	14
47	53 44	6 16	70909	93405	77505	22495	06595	29091	13
48	53 36	6 24	70931	93397	77533	22467	06603	29069	12
49	53 28	6 32	70952	93390	77562	22438	06610	29048	11
50	7 53 20	4 6 40	9 70973	9 93382	9 77591	10 22409	10 06618	10 29027	10
51	53 12	6 48	70994	93375	77619	22381	06625	29006	9
52	53 4	6 56	71015	93367	77648	22352	06633	28985	8
53	52 56	7 4	71036	93360	77677	22323	06640	28964	7
54	52 48	7 12	71058	93352	77706	22294	06648	28942	6
55	7 52 40	4 7 20	9 71079	9 93344	9 77734	10 22266	10 06656	10 28921	5
56	52 32	7 28	71100	93337	77763	22237	06663	28900	4
57	52 24	7 36	71121	93329	77791	22209	06671	28879	3
58	52 16	7 44	71142	93322	77820	22180	06678	28858	2
59	52 8	7 52	71163	93314	77849	22151	06686	28837	1
60	52 0	8 0	71184	93307	77877	22123	06693	28816	0
M	Hour P. M.	Hour A. M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

120 Degs.

Degs. 20

TABLE XXVII.

215

Log. Sines, Tangents and Secants.

31 Degs.

Deg. 148.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 52 0	4 8 0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	51 52	8 8	71205	93299	77906	22094	06701	28795	59
2	51 44	8 16	71226	93291	77936	22065	06709	28774	58
3	51 36	8 24	71247	93284	77963	22037	06716	28753	57
4	51 28	8 32	71268	93276	77992	22008	06724	28732	56
5	7 51 20	4 8 40	9.71289	9.93269	9.78020	10.21980	10.06731	10.28711	55
6	51 12	8 48	71310	93261	78049	21951	06739	28690	54
7	51 4	8 56	71331	93253	78077	21923	06747	28669	53
8	50 56	9 4	71352	93246	78106	21894	06754	28648	52
9	50 48	9 12	71373	93238	78135	21865	06762	28627	51
10	7 50 40	4 9 20	9.71393	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	50 32	9 28	71414	93223	78192	21808	06777	28586	49
12	50 24	9 36	71435	93215	78220	21780	06785	28565	48
13	50 16	9 44	71456	93207	78249	21751	06793	28544	47
14	50 8	9 52	71477	93200	78277	21723	06800	28523	46
15	7 50 0	4 10 0	9.71498	9.93192	9.78306	10.21694	10.06808	10.28502	45
16	49 52	10 8	71519	93184	78334	21666	06816	28481	44
17	49 44	10 16	71539	93177	78363	21637	06823	28461	43
18	49 36	10 24	71560	93169	78391	21609	06831	28440	42
19	49 28	10 32	71581	93161	78419	21581	06839	28419	41
20	7 49 20	4 10 40	9.71602	9.93164	9.78448	10.21551	10.06846	10.28398	40
21	49 12	10 48	71622	93146	78476	21524	06854	28378	39
22	49 4	10 56	71643	93138	78505	21495	06862	28357	38
23	48 56	11 4	71664	93131	78533	21467	06869	28336	37
24	48 48	11 12	71685	93123	78562	21438	06877	28315	36
25	7 48 40	4 11 20	9.71705	9.93115	9.78590	10.21410	10.06885	10.28295	35
26	48 32	11 28	71726	93108	78618	21382	06892	28274	34
27	48 24	11 36	71747	93100	78647	21353	06900	28253	33
28	48 16	11 44	71767	93092	78675	21325	06908	28233	32
29	48 8	11 52	71788	93084	78704	21296	06916	28212	31
30	7 48 0	4 12 0	9.71809	9.93077	9.78732	10.21268	10.06923	10.28191	30
31	47 52	12 8	71829	93069	78760	21240	06931	28171	29
32	47 44	12 16	71850	93061	78789	21211	06939	28150	28
33	47 36	12 24	71870	93053	78817	21183	06947	28130	27
34	47 28	12 32	71891	93045	78845	21155	06954	28109	26
35	7 47 20	4 12 40	9.71911	9.93038	9.78874	10.21126	10.06962	10.28089	25
36	47 12	12 48	71932	93030	78902	21098	06970	28068	24
37	47 4	12 56	71952	93022	78930	21070	06978	28048	23
38	46 56	13 4	71973	93014	78959	21041	06986	28027	22
39	46 48	13 12	71994	93007	78987	21013	06993	28006	21
40	7 46 40	4 13 20	9.72014	9.92999	9.79015	10.20985	10.07001	10.27986	20
41	46 32	13 28	72034	92991	79043	20957	07009	27966	19
42	46 24	13 36	72055	92983	79072	20928	07017	27945	18
43	46 16	13 44	72075	92976	79100	20900	07024	27925	17
44	46 8	13 52	72096	92968	79128	20872	07032	27904	16
45	7 46 0	4 14 0	9.72116	9.92960	9.79156	10.20844	10.07040	10.27884	15
46	45 52	14 8	72137	92952	79185	20815	07048	27863	14
47	45 44	14 16	72157	92944	79213	20787	07056	27843	13
48	45 36	14 24	72177	92936	79241	20759	07064	27823	12
49	45 28	14 32	72198	92929	79269	20731	07071	27802	11
50	7 45 20	4 14 40	9.72218	9.92921	9.79297	10.20703	10.07079	10.27782	10
51	45 12	14 48	72238	92913	79326	20674	07087	27762	9
52	45 4	14 56	72259	92906	79354	20646	07095	27741	8
53	44 56	15 4	72279	92897	79382	20618	07103	27721	7
54	44 48	15 12	72299	92889	79410	20590	07111	27701	6
55	7 44 40	4 15 20	9.72320	9.92881	9.79438	10.20562	10.07119	10.27680	5
56	44 32	15 28	72340	92874	79466	20534	07126	27660	4
57	44 24	15 36	72360	92866	79495	20505	07134	27640	3
58	44 16	15 44	72381	92858	79523	20477	07142	27619	2
59	44 8	15 52	72401	92850	79551	20449	07150	27599	1
60	44 0	16 0	72421	92842	79579	20421	07158	27579	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine	Co-tang.	Tangent.	Co-secant.	Secant.	M

121 Degs.

Degs. 52.

TABLE XXVII.

Log. Sines, Tangents and Secants.

32 Degs.

Degs. 147

M	Hour M	Hour P.M.	Sine.	Co-sine	Tangent	Co-tang	Secant	Co-secant	M
0	7 41 0	4 16 0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	43 52	16 8	72441	92834	79607	20393	07166	27559	59
2	43 44	16 16	72461	92826	79635	20365	07174	27539	58
3	43 36	16 24	72482	92818	79663	20337	07182	27518	57
4	43 28	16 32	72502	92810	79691	20309	07190	27498	56
5	7 43 20	4 16 40	9.72522	9.92803	9.79719	10.20281	10.07197	10.27478	55
6	43 12	16 48	72542	92795	79747	20253	07205	27458	54
7	43 4	16 56	72562	92787	79776	20224	07213	27438	53
8	42 56	17 4	72582	92779	79804	20196	07221	27418	52
9	42 48	17 12	72602	92771	79832	20168	07229	27398	51
10	7 42 40	4 17 20	9.72622	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	42 32	17 28	72643	92755	79888	20112	07245	27357	49
12	42 24	17 36	72663	92747	79916	20084	07253	27337	48
13	42 16	17 44	72683	92739	79944	20056	07261	27317	47
14	42 8	17 52	72703	92731	79972	20028	07269	27297	46
15	7 42 0	4 18 0	9.72723	9.92723	9.80000	10.20000	10.07277	10.27277	45
16	41 52	18 8	72743	92715	80028	19972	07285	27257	44
17	41 44	18 16	72763	92707	80056	19944	07293	27237	43
18	41 36	18 24	72783	92699	80084	19916	07301	27217	42
19	41 28	18 32	72803	92691	80112	19888	07309	27197	41
20	7 41 20	4 18 40	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	41 12	18 48	72843	92675	80168	19832	07325	27157	39
22	41 4	18 56	72863	92667	80195	19805	07333	27137	38
23	40 56	19 4	72883	92659	80223	19777	07341	27117	37
24	40 48	19 12	72902	92651	80251	19749	07349	27098	36
25	7 40 40	4 19 20	9.72922	9.92643	9.80279	10.19721	10.07357	10.27078	35
26	40 32	19 28	72942	92635	80307	19693	07365	27058	34
27	40 24	19 36	72962	92627	80335	19665	07373	27038	33
28	40 16	19 44	72982	92619	80363	19637	07381	27018	32
29	40 8	19 52	73002	92611	80391	19609	07389	26998	31
30	7 40 0	4 20 0	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
31	39 52	20 8	73041	92595	80447	19553	07405	26959	29
32	39 44	20 16	73061	92587	80474	19526	07413	26939	28
33	39 36	20 24	73081	92579	80502	19498	07421	26919	27
34	39 28	20 32	73101	92571	80530	19470	07429	26899	26
35	7 39 20	4 20 40	9.73121	9.92563	9.80558	10.19442	10.07437	10.26879	25
36	39 12	20 48	73140	92555	80586	19414	07445	26860	24
37	39 4	20 56	73160	92546	80614	19386	07453	26840	23
38	38 56	21 4	73180	92538	80642	19358	07461	26820	22
39	38 48	21 12	73200	92530	80669	19331	07470	26800	21
40	7 38 40	4 21 20	9.73219	9.92542	9.80697	10.19303	10.07478	10.26781	20
41	38 32	21 28	73239	92514	80725	19275	07486	26761	19
42	38 24	21 36	73259	92506	80753	19247	07494	26741	18
43	38 16	21 44	73278	92498	80781	19219	07502	26722	17
44	38 8	21 52	73298	92490	80808	19192	07510	26702	16
45	7 38 0	4 22 0	9.73318	9.92482	9.80836	10.19164	10.07518	10.26682	15
46	37 52	22 8	73337	92473	80864	19136	07527	26663	14
47	37 44	22 16	73357	92465	80892	19108	07535	26643	13
48	37 36	22 24	73377	92457	80919	19081	07543	26623	12
49	37 28	22 32	73396	92449	80947	19053	07551	26604	11
50	7 37 20	4 22 40	9.73416	9.92441	9.80975	10.19025	10.07559	10.26584	10
51	37 12	22 48	73435	92433	81003	18997	07567	26565	9
52	37 4	22 56	73455	92425	81030	18970	07575	26545	8
53	36 56	23 4	73474	92416	81058	18942	07584	26526	7
54	36 48	23 12	73494	92408	81086	18914	07592	26506	6
55	7 36 40	4 23 20	9.73513	9.92400	9.81113	10.18887	10.07600	10.26487	5
56	36 32	23 28	73533	92392	81141	18859	07608	26467	4
57	36 24	23 36	73552	92384	81169	18831	07616	26448	3
58	36 16	23 44	73572	92376	81196	18804	07624	26428	2
59	36 8	23 52	73591	92367	81224	18776	07632	26409	1
60	36 0	24 0	73611	92359	81252	18748	07641	26389	0
M	Hour M	Hour P.M.	Co-sine	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

122 Degs.

Degs. 57

TABLE XXVII.
Log. Sines, Tangents and Secants.

217

123 Degs.

Degs. 146.

M	Hour. m.	Hour. m.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M
0	7 36 00	4 24 00	9 73611	9 92389	9.81252	10.18748	10 07641	10 26389	60
1	36 02	24 02	73630	92371	81279	18721	07649	26370	59
2	36 04	24 04	73650	92353	81307	18693	07657	26350	58
3	36 06	24 06	73669	92335	81335	18665	07665	26331	57
4	36 08	24 08	73689	92316	81362	18638	07673	26311	56
5	7 35 20	4 24 40	9 73708	9 92318	9.81390	10.18610	10.07682	10 26292	55
6	35 18	24 48	73727	92310	81418	18582	07690	26273	54
7	35 16	24 56	73747	92302	81445	18555	07698	26253	53
8	35 14	25 04	73766	92293	81473	18527	07707	26234	52
9	35 12	25 12	73785	92285	81500	18500	07715	26215	51
10	7 34 40	4 25 20	9 73805	9 92277	9 81528	10 18472	10 07723	10 26195	50
11	34 38	25 28	73824	92269	81555	18444	07731	26176	49
12	34 36	25 36	73843	92260	81583	18417	07740	26157	48
13	34 34	25 44	73863	92252	81611	18389	07748	26137	47
14	34 32	25 52	73882	92244	81638	18362	07756	26118	46
15	7 34 00	4 26 00	9 73901	9 92235	9 81666	10 18334	10 07765	10 26099	45
16	33 58	26 08	73921	92227	81693	18307	07773	26079	44
17	33 56	26 16	73940	92219	81721	18279	07781	26060	43
18	33 54	26 24	73959	92211	81748	18252	07789	26041	42
19	33 52	26 32	73978	92203	81776	18224	07798	26022	41
20	7 33 20	4 26 40	9 73997	9 92194	9 81803	10 18197	10 07806	10 26003	40
21	33 18	26 48	74017	92186	81831	18169	07814	25983	39
22	33 16	26 56	74036	92177	81858	18142	07823	25964	38
23	33 14	27 04	74055	92169	81886	18114	07831	25945	37
24	33 12	27 12	74074	92161	81913	18087	07839	25926	36
25	7 32 40	4 27 20	9 74093	9 92152	9 81941	10 18059	10 07848	10 25907	35
26	32 38	27 28	74113	92144	81968	18032	07856	25887	34
27	32 36	27 36	74132	92136	81996	18004	07864	25868	33
28	32 34	27 44	74151	92127	82023	17977	07873	25849	32
29	32 32	27 52	74170	92119	82051	17949	07881	25830	31
30	7 32 00	4 28 00	9 74189	9 92111	9 82078	10 17922	10 07889	10 25811	30
31	31 58	28 08	74208	92102	82106	17894	07898	25792	29
32	31 56	28 16	74227	92094	82133	17867	07906	25773	28
33	31 54	28 24	74246	92086	82161	17839	07914	25754	27
34	31 52	28 32	74265	92077	82188	17812	07923	25735	26
35	7 31 20	4 28 40	9 74284	9 92069	9 82215	10 17785	10 07931	10 25716	25
36	31 18	28 48	74303	92060	82243	17757	07940	25697	24
37	31 16	28 56	74322	92052	82270	17730	07948	25678	23
38	31 14	29 04	74341	92044	82298	17702	07956	25659	22
39	31 12	29 12	74360	92035	82325	17675	07965	25640	21
40	7 30 40	4 29 20	9 74379	9 92027	9 82352	10 17648	10 07973	10 25621	20
41	30 38	29 28	74398	92018	82380	17620	07982	25602	19
42	30 36	29 36	74417	92010	82407	17593	07990	25583	18
43	30 34	29 44	74436	92002	82435	17565	07998	25564	17
44	30 32	29 52	74455	91993	82462	17538	08007	25545	16
45	7 30 00	4 30 00	9 74474	9 91985	9 82489	10 17511	10 08015	10 25526	15
46	29 58	30 08	74493	91976	82517	17483	08024	25507	14
47	29 56	30 16	74512	91968	82544	17456	08032	25488	13
48	29 54	30 24	74531	91959	82571	17429	08041	25469	12
49	29 52	30 32	74549	91951	82599	17401	08049	25451	11
50	7 29 20	4 30 40	9 74568	9 91942	9 82626	10 17374	10 08058	10 25432	10
51	29 18	30 48	74587	91934	82653	17347	08066	25413	9
52	29 16	30 56	74606	91925	82681	17319	08075	25394	8
53	29 14	31 04	74625	91917	82708	17292	08083	25375	7
54	29 12	31 12	74644	91908	82735	17265	08092	25356	6
55	7 28 40	4 31 20	9 74662	9 91900	9 82762	10 17238	10 08100	10 25338	5
56	28 38	31 28	74681	91891	82790	17210	08109	25319	4
57	28 36	31 36	74700	91883	82817	17183	08117	25300	3
58	28 34	31 44	74719	91874	82844	17156	08126	25281	2
59	28 32	31 52	74737	91866	82871	17129	08134	25263	1
60	28 30	32 00	74756	91857	82898	17101	08143	25244	0
M	Hour. m.	Hour. m.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

123 Degs.

D d

Degs. 66.

TABLE XXVII.
Log. Sines, Tangents and Secants.

34 Degs.											Degs. 143.		
M	Hour	Min	Hour	Min	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M		
0	7	28	0	4	34	0	9.74756	9.91857	9.82399	10.17101	10.08143	10.25244	60
1		27	52		32	8	74775	91849	82926	17074	08151	25225	59
2		27	44		32	16	74794	91840	82953	17047	08160	25206	58
3		27	36		32	24	74812	91832	82980	17020	08168	25188	57
4		27	28		32	32	74831	91823	83008	16992	08177	25169	56
5	7	27	20	4	32	40	9.74850	9.91815	9.83035	10.16965	10.08185	10.25150	55
6		27	12		32	48	74868	91806	83062	16938	08194	25132	54
7		27	4		32	56	74887	91798	83089	16911	08202	25113	53
8		26	56		33	4	74906	91789	83117	16883	08211	25094	52
9		26	48		33	12	74924	91781	83144	16856	08219	25076	51
10	7	26	40	4	33	20	9.74943	9.91772	9.83171	10.16829	10.08228	10.25057	50
11		26	32		33	28	74961	91763	83198	16802	08237	25039	49
12		26	24		33	36	74980	91755	83225	16775	08245	25020	48
13		26	16		33	44	74999	91746	83252	16748	08254	25001	47
14		26	8		33	52	75017	91738	83280	16720	08262	24983	46
15	7	26	0	4	34	0	9.75036	9.91729	9.83307	10.16693	10.08271	10.24964	45
16		25	52		34	8	75054	91720	83334	16666	08280	24946	44
17		25	44		34	16	75073	91712	83361	16639	08288	24927	43
18		25	36		34	24	75091	91703	83388	16612	08297	24909	42
19		25	28		34	32	75110	91695	83415	16585	08305	24890	41
20	7	25	20	4	34	40	9.75128	9.91686	9.83442	10.16558	10.08314	10.24872	40
21		25	12		34	48	75147	91677	83470	16530	08323	24853	39
22		25	4		34	56	75165	91669	83497	16503	08331	24835	38
23		24	56		35	4	75184	91660	83524	16476	08340	24816	37
24		24	48		35	12	75202	91651	83551	16449	08349	24798	36
25	7	24	40	4	35	20	9.75221	9.91643	9.83578	10.16422	10.08357	10.24779	35
26		24	32		35	28	75239	91634	83605	16396	08366	24761	34
27		24	24		35	36	75258	91625	83632	16368	08375	24742	33
28		24	16		35	44	75276	91617	83659	16341	08383	24724	32
29		24	8		35	52	75294	91608	83686	16314	08392	24706	31
30	7	24	0	4	36	0	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31		23	52		36	8	75331	91591	83740	16260	08409	24669	29
32		23	44		36	16	75350	91582	83767	16232	08418	24650	28
33		23	36		36	24	75368	91573	83795	16205	08427	24632	27
34		23	28		36	32	75386	91565	83822	16178	08435	24614	26
35	7	23	20	4	36	40	9.75405	9.91556	9.83849	10.16161	10.08444	10.24595	25
36		23	12		36	48	75423	91547	83876	16134	08453	24577	24
37		23	4		36	56	75441	91538	83903	16107	08462	24559	23
38		22	56		37	4	75459	91530	83930	16070	08470	24541	22
39		22	48		37	12	75478	91521	83957	16043	08479	24522	21
40	7	22	40	4	37	20	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41		22	32		37	28	75514	91504	84011	15989	08496	24486	19
42		22	24		37	36	75533	91495	84038	15962	08505	24467	18
43		22	16		37	44	75551	91486	84065	15935	08514	24449	17
44		22	8		37	52	75569	91477	84092	15908	08523	24431	16
45	7	22	0	4	38	0	9.75587	9.91469	9.84119	10.15881	10.08531	10.24413	15
46		21	52		38	8	75605	91460	84146	15854	08540	24395	14
47		21	44		38	16	75624	91451	84173	15827	08549	24376	13
48		21	36		38	24	75642	91442	84200	15800	08558	24358	12
49		21	28		38	32	75660	91433	84227	15773	08567	24340	11
50	7	21	20	4	38	40	9.75678	9.91425	9.84254	10.15746	10.08575	10.24322	10
51		21	12		38	48	75696	91416	84280	15720	08584	24304	9
52		21	4		38	56	75714	91407	84307	15693	08593	24286	8
53		20	56		39	4	75733	91398	84334	15666	08602	24267	7
54		20	48		39	12	75751	91389	84361	15639	08611	24249	6
55	7	20	40	4	39	20	9.75769	9.91381	9.84388	10.15612	10.08619	10.24231	5
56		20	32		39	28	75787	91372	84415	15585	08628	24213	4
57		20	24		39	36	75806	91363	84442	15558	08637	24195	3
58		20	16		39	44	75823	91354	84469	15531	08646	24177	2
59		20	8		39	52	75841	91345	84496	15504	08655	24159	1
60		20	0		40	0	75859	91336	84523	15477	08664	24141	0
	Hour	Min	Hour	Min	Co-sine	Sine	Co-tang.	Tangent	Co-secant	Secant			M
154 Degs.											Degs. 54.		

134 Degs.

Degs. 45.

TABLE XXVII.

219

Log. Sines, Tangents and Secants.

35 Degs.

Degs. 144.

M	Hour. m.	Hour. m.	Sine	Co-sine	Tangent	Co-tang.	Secant	Co-secant	M
0	7 20 0	4 40 0	9 75839	9 91334	9 84523	10 15477	10 08664	10 24141	60
1	19 52	40 8	75877	91320	84530	15450	08672	24123	59
2	19 44	40 16	75905	91319	84576	15424	08681	24105	58
3	19 36	40 24	75913	91310	84603	15397	08690	24087	57
4	19 28	40 32	75931	91301	84630	15370	08699	24069	56
5	7 19 20	4 40 40	9 75949	9 91294	9 84657	10 15343	10 08708	10 24051	55
6	19 12	40 48	75967	91283	84684	15316	08717	24033	54
7	19 4	40 56	75985	91274	84711	15289	08726	24015	53
8	18 56	41 4	76003	91266	84738	15262	08734	23997	52
9	18 48	41 12	76021	91257	84764	15236	08743	23979	51
10	7 18 40	4 41 20	9 76039	9 91248	9 84791	10 15209	10 08752	10 23961	50
11	18 32	41 28	76057	91239	84818	15182	08761	23943	49
12	18 24	41 36	76075	91230	84845	15155	08770	23925	48
13	18 16	41 44	76093	91221	84872	15128	08779	23907	47
14	18 8	41 52	76111	91212	84899	15101	08788	23889	46
15	7 18 0	4 42 0	9 76129	9 91203	9 84926	10 15075	10 08797	10 23871	45
16	17 52	42 8	76146	91194	84953	15043	08806	23854	44
17	17 44	42 16	76164	91185	84979	15021	08815	23836	43
18	17 36	42 24	76182	91176	85006	14994	08824	23818	42
19	17 28	42 32	76200	91167	85033	14967	08833	23800	41
20	7 17 20	4 42 40	9 76218	9 91158	9 85059	10 14941	10 08842	10 23782	40
21	17 12	42 48	76236	91149	85086	14914	08851	23764	39
22	17 4	42 56	76253	91141	85113	14887	08859	23747	38
23	16 56	43 4	76271	91132	85140	14860	08868	23729	37
24	16 48	43 12	76289	91123	85166	14834	08877	23711	36
25	7 16 40	4 43 20	9 76307	9 91114	9 85193	10 14807	10 08886	10 23693	35
26	16 32	43 28	76324	91105	85220	14780	08895	23676	34
27	16 24	43 36	76342	91096	85247	14753	08904	23658	33
28	16 16	43 44	76360	91087	85273	14727	08913	23640	32
29	16 8	43 52	76378	91078	85300	14700	08922	23622	31
30	7 16 0	4 44 0	9 76396	9 91064	9 85327	10 14673	10 08931	10 23608	30
31	15 52	44 8	76413	91055	85354	14646	08940	23590	29
32	15 44	44 16	76431	91046	85380	14620	08949	23572	28
33	15 36	44 24	76448	91042	85407	14593	08958	23554	27
34	15 28	44 32	76466	91033	85434	14566	08967	23536	26
35	7 15 20	4 44 40	9 76484	9 91023	9 85461	10 14540	10 08977	10 23516	25
36	15 12	44 48	76501	91014	85487	14513	08986	23499	24
37	15 4	44 56	76519	91005	85514	14486	08995	23481	23
38	14 56	45 4	76537	90996	85540	14460	09004	23463	22
39	14 48	45 12	76554	90987	85567	14433	09013	23446	21
40	7 14 40	4 45 20	9 76572	9 90978	9 85594	10 14406	10 09022	10 23426	20
41	14 32	45 28	76590	90969	85620	14380	09031	23408	19
42	14 24	45 36	76607	90960	85647	14353	09040	23390	18
43	14 16	45 44	76625	90951	85674	14326	09049	23372	17
44	14 8	45 52	76642	90942	85700	14300	09058	23354	16
45	7 14 0	4 46 0	9 76660	9 90933	9 85727	10 14273	10 09067	10 23340	15
46	13 52	46 8	76677	90924	85754	14246	09076	23322	14
47	13 44	46 16	76695	90915	85780	14220	09085	23304	13
48	13 36	46 24	76712	90906	85807	14193	09094	23286	12
49	13 28	46 32	76730	90896	85834	14166	09104	23270	11
50	7 13 20	4 46 40	9 76747	9 90887	9 85860	10 14140	10 09113	10 23253	10
51	13 12	46 48	76765	90878	85887	14113	09122	23235	9
52	13 4	46 56	76782	90869	85913	14087	09131	23217	8
53	12 56	47 4	76800	90860	85940	14060	09140	23200	7
54	12 48	47 12	76817	90851	85967	14033	09149	23183	6
55	7 12 40	4 47 20	9 76835	9 90842	9 85993	10 14007	10 09158	10 23166	5
56	12 32	47 28	76852	90832	86020	13980	09167	23148	4
57	12 24	47 36	76870	90823	86046	13954	09177	23130	3
58	12 16	47 44	76887	90814	86073	13927	09186	23113	2
59	12 8	47 52	76905	90805	86100	13900	09195	23096	1
60	12 0	48 0	76922	90796	86126	13874	09204	23079	0
M	Hour. m.	Hour. m.	Co-sine	Sine	Co-tang.	Tangent	Co-secant	Secant	M

125 Degs.

Degs. 54.

TABLE XXVII.

Log. Sines, Tangents and Secants.

36 Degs.

Degs. 143.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 12 0	4 48 0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	11 52	48 8	76939	90787	86153	13847	09213	23061	59
2	11 44	48 16	76957	90777	86179	13821	09223	23043	58
3	11 36	48 24	76974	90768	86206	13794	09232	23026	57
4	11 28	48 32	76991	90759	86232	13768	09241	23009	56
5	7 11 20	4 48 40	9.77009	9.90750	9.86259	10.13741	10.09250	10.22991	55
6	11 12	48 48	77026	90741	86285	13715	09259	22974	54
7	11 4	48 56	77043	90731	86312	13688	09269	22957	53
8	10 56	49 4	77061	90722	86338	13662	09278	22939	52
9	10 48	49 12	77078	90713	86365	13635	09287	22922	51
10	7 10 40	4 49 20	9.77095	9.90704	9.86392	10.13603	10.09296	10.22905	50
11	10 32	49 28	77112	90694	86418	13582	09306	22888	49
12	10 24	49 36	77130	90685	86445	13555	09315	22870	48
13	10 16	49 44	77147	90676	86471	13529	09324	22853	47
14	10 8	49 52	77164	90667	86498	13502	09333	22836	46
15	7 10 0	4 50 0	9.77181	9.90657	9.86524	10.13476	10.09343	10.22819	45
16	9 52	50 8	77199	90648	86551	13449	09352	22801	44
17	9 44	50 16	77216	90639	86577	13423	09361	22784	43
18	9 36	50 24	77233	90630	86603	13397	09370	22767	42
19	9 28	50 32	77250	90621	86630	13370	09380	22750	41
20	7 9 20	4 50 40	9.77268	9.90611	9.86656	10.13344	10.09389	10.22732	40
21	9 12	50 48	77285	90602	86683	13317	09398	22715	39
22	9 4	50 56	77302	90592	86709	13291	09408	22698	38
23	8 56	51 4	77319	90583	86736	13264	09417	22681	37
24	8 48	51 12	77336	90574	86762	13238	09426	22664	36
25	7 8 40	4 51 20	9.77353	9.90565	9.86759	10.13211	10.09435	10.22647	35
26	8 32	51 28	77370	90555	86815	13185	09445	22630	34
27	8 24	51 36	77387	90546	86842	13158	09454	22613	33
28	8 16	51 44	77405	90537	86868	13132	09463	22595	32
29	8 8	51 52	77422	90527	86894	13106	09473	22578	31
30	7 8 0	4 52 0	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
31	7 52	52 8	77456	90509	86947	13053	09491	22544	29
32	7 44	52 16	77473	90499	86974	13026	09501	22527	28
33	7 36	52 24	77490	90490	87000	13000	09510	22510	27
34	7 28	52 32	77507	90480	87027	12973	09520	22493	26
35	7 7 20	4 52 40	9.77524	9.90471	9.87053	10.12947	10.09529	10.22476	25
36	7 12	52 48	77541	90462	87079	12921	09538	22459	24
37	7 4	52 56	77558	90452	87106	12894	09548	22442	23
38	6 56	53 4	77575	90443	87132	12868	09557	22425	22
39	6 48	53 12	77592	90434	87158	12842	09566	22408	21
40	7 6 40	4 53 20	9.77609	9.90424	9.87185	10.12815	10.09576	10.22391	20
41	6 32	53 28	77626	90415	87211	12789	09585	22374	19
42	6 24	53 36	77643	90405	87238	12762	09595	22357	18
43	6 16	53 44	77660	90396	87264	12736	09604	22340	17
44	6 8	53 52	77677	90386	87290	12710	09614	22323	16
45	7 6 0	4 54 0	9.77694	9.90377	9.87317	10.12683	10.09623	10.22306	15
46	5 52	54 8	77711	90368	87343	12657	09632	22289	14
47	5 44	54 16	77728	90358	87369	12631	09642	22272	13
48	5 36	54 24	77744	90349	87396	12604	09651	22256	12
49	5 28	54 32	77761	90339	87422	12578	09661	22239	11
50	7 5 20	4 54 40	9.77778	9.90330	9.87448	10.12552	10.09670	10.22222	10
51	5 12	54 48	77795	90320	87475	12525	09680	22205	9
52	5 4	54 56	77812	90311	87501	12499	09689	22188	8
53	4 56	55 4	77829	90301	87527	12473	09699	22171	7
54	4 48	55 12	77846	90292	87554	12446	09708	22154	6
55	7 4 40	4 55 20	9.77862	9.90282	9.87580	10.12420	10.09718	10.22138	5
56	4 32	55 28	77879	90273	87606	12394	09727	22121	4
57	4 24	55 36	77896	90263	87633	12367	09737	22104	3
58	4 16	55 44	77913	90254	87659	12341	09746	22087	2
59	4 8	55 52	77930	90244	87685	12315	09756	22070	1
60	4 0	56 0	77946	90235	87711	12289	09765	22054	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

126 Degs.

Degs. 43.

TABLE XXVII.

221

Log. Sines, Tangents and Secants.

37 Degs.

Degs. 142.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 4 0	4 56 0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
1	3 52	56 8	77963	90225	87738	12262	09775	22037	59
2	3 44	56 16	77980	90216	87764	12236	09784	22020	58
3	3 36	56 24	77997	90206	87790	12210	09794	22003	57
4	3 28	56 32	78013	90197	87817	12183	09803	21987	56
5	7 3 20	4 56 40	9.78030	9.90187	9.87843	10.12157	10.09813	10.21970	55
6	3 12	56 48	78047	90173	87869	12131	09822	21953	54
7	3 4	56 56	78063	90168	87895	12105	09832	21937	53
8	2 56	57 4	78080	90159	87922	12078	09841	21920	52
9	2 48	57 12	78097	90149	87948	12052	09851	21903	51
10	7 2 40	4 57 20	9.78113	9.90139	9.87974	10.12026	10.09861	10.21887	50
11	2 32	57 28	78130	90130	88000	12000	09870	21870	49
12	2 24	57 36	78147	90120	88027	11973	09880	21853	48
13	2 16	57 44	78163	90111	88053	11947	09889	21837	47
14	2 8	57 52	78180	90101	88079	11921	09899	21820	46
15	7 2 0	4 58 0	9.78197	9.90091	9.88106	10.11895	10.09909	10.21803	45
16	1 52	58 8	78213	90082	88131	11869	09918	21787	44
17	1 44	58 16	78230	90072	88158	11842	09928	21770	43
18	1 36	58 24	78246	90063	88184	11816	09937	21754	42
19	1 28	58 32	78263	90053	88210	11790	09947	21737	41
20	7 1 20	4 58 40	9.78280	9.90043	9.88236	10.11764	10.09957	10.21720	40
21	1 12	58 48	78296	90034	88262	11738	09966	21704	39
22	1 4	58 56	78313	90024	88289	11711	09976	21687	38
23	0 56	59 4	78329	90014	88315	11685	09986	21671	37
24	0 48	59 12	78346	90005	88341	11659	09995	21654	36
25	7 0 40	4 59 20	9.78362	9.89995	9.88367	10.11633	10.10005	10.21638	35
26	0 32	59 28	78379	89985	88393	11607	10015	21621	34
27	0 24	59 36	78395	89976	88420	11580	10024	21605	33
28	0 16	59 44	78412	89966	88446	11554	10034	21588	32
29	0 8	59 52	78428	89956	88472	11528	10044	21572	31
30	7 0 0	5 0 0	9.78445	9.89947	9.88498	10.11502	10.10053	10.21555	30
31	6 59 52	0 8	78461	89937	88524	11476	10063	21539	29
32	59 44	0 16	78478	89927	88550	11450	10073	21522	28
33	59 36	0 24	78494	89918	88577	11423	10082	21506	27
34	59 28	0 32	78510	89908	88603	11397	10092	21490	26
35	6 59 20	5 0 40	9.78527	9.89898	9.88629	10.11371	10.10102	10.21473	25
36	59 12	0 48	78543	89888	88655	11345	10112	21457	24
37	59 4	0 56	78560	89879	88681	11319	10121	21440	23
38	58 56	1 4	78576	89869	88707	11293	10131	21424	22
39	58 48	1 12	78592	89859	88733	11267	10141	21408	21
40	6 58 40	5 1 20	9.78609	9.89849	9.88759	10.11241	10.10151	10.21391	20
41	58 32	1 28	78625	89840	88786	11214	10160	21375	19
42	58 24	1 36	78642	89830	88812	11188	10170	21358	18
43	58 16	1 44	78658	89820	88838	11162	10180	21342	17
44	58 8	1 52	78674	89810	88864	11136	10190	21326	16
45	6 58 0	5 2 0	9.78691	9.89801	9.88890	10.11110	10.10199	10.21309	15
46	57 52	2 8	78707	89791	88916	11084	10209	21293	14
47	57 44	2 16	78723	89781	88942	11058	10219	21277	13
48	57 36	2 24	78739	89771	88968	11032	10229	21261	12
49	57 28	2 32	78756	89761	88994	11006	10239	21244	11
50	6 57 20	5 2 40	9.78772	9.89752	9.89020	10.10980	10.10248	10.21228	10
51	57 12	2 48	78788	89742	89046	10954	10258	21212	9
52	57 4	2 56	78805	89732	89073	10927	10263	21195	8
53	56 56	3 4	78821	89722	89099	10901	10278	21179	7
54	56 48	3 12	78837	89712	89125	10875	10288	21163	6
55	6 56 40	5 3 20	9.78853	9.89702	9.89151	10.10849	10.10298	10.21147	5
56	56 32	3 28	78869	89693	89177	10823	10307	21131	4
57	56 24	3 36	78886	89683	89203	10797	10317	21114	3
58	56 16	3 44	78902	89673	89229	10771	10327	21098	2
59	56 8	3 52	78918	89663	89255	10745	10337	21082	1
60	56 0	4 0	78934	89653	89281	10719	10347	21066	0

M Hour P.M.

Hour A.M.

Co-sine.

Sine.

Co-tang.

Tangent.

Co-secant

Secant.

M

127 Degs.

Degs. 52.

TABLE XXVII.

223

Log. Sines, Tangents and Secants.

39 Degs.

Deg. 140.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 48 0	5 12 0	9 79887	9 89050	9 90837	10 09163	10 10950	10 20113	60
1	47 52	12 8	79903	89040	90863	09137	10960	20097	59
2	47 44	12 16	79918	89050	90869	09111	10970	20082	58
3	47 36	12 24	79934	89020	90914	09086	10980	20066	57
4	47 28	12 32	79950	89009	90940	09060	10991	20050	56
5	6 47 20	5 12 40	9 79965	9 88999	9 90966	10 09034	10 11601	10 20035	55
6	47 12	12 48	79981	88989	90992	09008	11011	20019	54
7	47 4	12 56	79996	88978	91018	08982	11022	20004	53
8	46 56	13 4	80012		91043	08957	11032	19988	52
9	46 48	13 12	80027	88958	91069	08931	11042	19973	51
10	6 46 40	5 13 20	9 80043	9 88948	9 91095	10 08905	10 11052	10 19957	50
11	46 32	13 28	80058	88937	91121	08879	11063	19942	49
12	46 24	13 36	80074	88927	91147	08853	11073	19926	48
13	46 16	13 44	80089	88917	91172	08828	11083	19911	47
14	46 8	13 52	80105	88906	91198	08802	11094	19895	46
15	6 46 0	5 14 0	9 80120	9 88896	9 91224	10 08776	10 11104	10 19880	45
16	45 52	14 8	80136	88886	91250	08750	11114	19864	44
17	45 44	14 16	80151	88875	91276	08724	11125	19849	43
18	45 36	14 24	80166	88865	91301	08699	11136	19834	42
19	45 28	14 32	80182	88855	91327	08673	11146	19818	41
20	6 45 20	5 14 40	9 80197	9 88844	9 91353	10 08647	10 11256	10 19803	40
21	45 12	14 48	80213	88834	91379	08621	11166	19787	39
22	45 4	14 56	80228	88824	91404	08596	11176	19772	38
23	44 56	15 4	80244	88813	91430	08570	11187	19756	37
24		15 12	80259	88803	91456	08544	11197	19741	36
25	6 44 40	5 15 20	9 80274	9 88793	9 91482	10 08518	10 11207	10 19726	35
26	44 32	15 28	80290	88782	91507	08493	11218	19710	34
27	44 24	15 36	80305	88772	91533	08467		19695	33
28	44 16	15 44	80320	88761	91559	08441	11239		
29	44 8	15 52	80336	88751	91585	08415	11249	19664	31
30	6 44 0	5 16 0	9 80351	9 88741	9 91610	10 08390	10 11259	10 19649	30
31	43 52	16 8	80366	88730	91636	08364	11270	19634	29
32	43 44	16 16	80382	88720	91662	08338	11280	19618	28
33	43 36	16 24	80397	88709	91688	08312	11291	19603	27
34	43 28	16 32	80412	88699	91713	08287	11301	19588	26
35	6 43 20	5 16 40	9 80428	9 88688	9 91739	10 08261	10 11312	10 19572	25
36	43 12	16 48	80443	88678	91765	08235	11322	19557	24
37	43 4	16 56	80458	88668	91791	08209	11332	19542	23
38	42 56	17 4	80473	88657	91816	08184	11343	19527	22
39	42 48	17 12	80489	88647	91842	08158	11353	19511	21
40	6 42 40	5 17 20	9 80504	9 88636	9 91868	10 08132	10 11364	10 19496	20
41	42 32	17 28	80519	88626	91893	08107	11374	19481	19
42	42 24	17 36	80534	88615	91919	08081	11385	19466	18
43	42 16	17 44	80550	88605	91945	08055	11395	19450	17
44	42 8	17 52	80565	88594	91971	08029	11406	19435	16
45	6 42 0	5 18 0	9 80580	9 88584	9 91996	10 08004	10 11416	10 19420	15
46	41 52	18 8	80595	88573	92022	07978	11427	19405	14
47	41 44	18 16	80610	88563	92048	07952	11437	19390	13
48	41 36	18 24	80625	88552	92073	07927	11448	19375	12
49	41 28	18 32	80641	88542	92099	07901	11458	19359	11
50	6 41 20	5 18 40	9 80656	9 88531	9 92125	10 07875	10 11469	10 19344	10
51	41 12	18 48	80671	88521	92150	07850	11479	19329	9
52	41 4	18 56	80686	88510	92176	07824	11490	19314	8
53	40 56	19 4	80701	88499	92202	07798	11501	19299	7
54	40 48	19 12	80716	88489	92227	07773	11511	19284	6
55	6 40 40	5 19 20	9 80731	9 88478	9 92253	10 07747	10 11522	10 19269	5
56	40 32	19 28	80746	88468	92279	07721	11532	19254	4
57	40 24	19 36	80762	88457	92304	07696	11543	19238	3
58	40 16	19 44	80777	88447	92330	07670	11553	19223	2
59	40 8	19 52	80792	88436	92356	07644	11564	19208	1
60	40 0	20 0	80807	88425	92381	07619	11575	19193	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

129 Degs.

Degs. 50.

40 Degs.

Degs. 139

M	Hour P.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	
0	6 40 0	5 20 0	9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	6
1	39 52	20 8	80822	88415	92407	07593	11585	19178	5
2	39 44	20 16	80837	88404	92433	07567	11596	19163	5
3	39 36	20 24	80852	88394	92458	07542	11606	19148	5
4	39 28	20 32	80867	88383	92484	07516	11617	19133	5
5	6 39 20	5 20 40	9.80882	9.88372	9.92510	10.07490	10.11628	10.19118	5
6	39 12	20 48	80897	88362	92535	07465	11638	19103	5
7	39 4	20 56	80912	88351	92561	07439	11649	19088	5
8	38 56	21 4	80927	88340	92587	07413	11660	19073	5
9	38 48	21 12	80942	88330	92612	07388	11670	19058	5
10	6 38 40	5 21 20	9.80957	9.88219	9.92638	10.07362	10.11681	10.19043	5
11	38 32	21 28	80972	88308	92663	07337	11692	19028	4
12	38 24	21 36	80987	88298	92689	07311	11702	19013	4
13	38 16	21 44	81002	88287	92715	07285	11713	18998	4
14	38 8	21 52	81017	88276	92740	07260	11724	18983	4
15	6 38 0	5 22 0	9.81032	9.88266	9.92766	10.07234	10.11734	10.18968	4
16	37 52	22 8	81047	88255	92792	07208	11745	18953	4
17	37 44	22 16	81061	88244	92817	07183	11756	18939	4
18	37 36	22 24	81076	88234	92843	07157	11766	18924	4
19	37 28	22 32	81091	88223	92868	07132	11777	18909	4
20	6 37 20	5 22 40	9.81106	9.88212	9.92894	10.07106	10.11788	10.18894	4
21	37 12	22 48	81121	88201	92920	07080	11799	18879	3
22	37 4	22 56	81136	88191	92945	07055	11809	18864	3
23	36 56	23 4	81151	88180	92971	07029	11820	18849	3
24	36 48	23 12	81166	88169	92996	07004	11831	18834	3
25	6 36 40	5 23 20	9.81180	9.88158	9.93022	10.06978	10.11842	10.18820	3
26	36 32	23 28	81195	88147	93048	06952	11852	18805	3
27	36 24	23 36	81210	88137	93073	06927	11863	18790	3
28	36 16	23 44	81225	88126	93099	06901	11874	18775	3
29	36 8	23 52	81240	88115	93124	06876	11885	18760	3
30	6 36 0	5 24 0	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	3
31	35 52	24 8	81269	88094	93175	06825	11906	18731	2
32	35 44	24 16	81284	88083	93201	06799	11917	18716	2
33	35 36	24 24	81299	88072	93227	06773	11928	18701	2
34	35 28	24 32	81314	88061	93252	06748	11939	18686	2
35	6 35 20	5 24 40	9.81328	9.88051	9.93278	10.06722	10.11949	10.18672	2
36	35 12	24 48	81343	88040	93303	06697	11960	18657	2
37	35 4	24 56	81358	88029	93329	06671	11971	18642	2
38	34 56	25 4	81372	88018	93354	06646	11982	18627	2
39	34 48	25 12	81387	88007	93380	06620	11993	18613	2
40	6 34 40	5 25 20	9.81402	9.87996	9.93406	10.06594	10.12004	10.18598	2
41	34 32	25 28	81417	87985	93431	06569	12015	18583	2
42	34 24	25 36	81431	87975	93457	06543	12025	18568	2
43	34 16	25 44	81446	87964	93482	06518	12036	18554	2
44	34 8	25 52	81461	87953	93508	06492	12047	18539	2
45	6 34 0	5 26 0	9.81475	9.87942	9.93533	10.06467	10.12058	10.18525	2
46	33 52	26 8	81490	87931	93559	06441	12069	18510	2
47	33 44	26 16	81505	87920	93584	06416	12080	18495	2
48	33 36	26 24	81519	87909	93610	06390	12091	18480	2
49	33 28	26 32	81534	87898	93636	06364	12102	18465	2
50	6 33 20	5 26 40	9.81549	9.87887	9.93661	10.06339	10.12113	10.18451	2
51	33 12	26 48	81563	87877	93687	06313	12123	18436	2
52	33 4	26 56	81578	87866	93712	06288	12134	18421	2
53	32 56	27 4	81592	87855	93738	06262	12145	18406	2
54	32 48	27 12	81607	87844	93763	06237	12156	18391	2
55	6 32 40	5 27 20	9.81622	9.87833	9.93789	10.06211	10.12167	10.18377	2
56	32 32	27 28	81636	87822	93814	06186	12178	18362	2
57	32 24	27 36	81651	87811	93840	06160	12189	18347	2
58	32 16	27 44	81665	87800	93865	06135	12200	18332	2
59	32 8	27 52	81680	87789	93891	06109	12211	18317	2
60	32 0	28 0	81694	87778	93916	06084	12222	18302	2
M	Hour P.M.	Hour P.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant	Degs.

130 Degs.

Degs.

TABLE XXVII.
Log. Sines, Tangents and Secants.

225

41 Degs.										Degs. 138.	
M	Hour. M.	Hour. M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M		
0	6 32 0	5 28 0	9 81694	9 87778	9 93916	10 06084	10 12222	10 18396	60		
1	31 52	29 8	81700	87767	93942	06038	12211	18291	59		
2	31 44	29 16	81723	87756	93967	06033	12241	18277	58		
3	31 36	29 24	81738	87745	93993	06007	12255	18262	57		
4	31 28	29 32	81752	87734	94018	05982	12266	18248	56		
5	6 31 20	5 29 40	9 81767	9 87723	9 94044	10 05966	10 12277	10 18233	55		
6	31 12	29 48	81781	87712	94069	05931	12286	18219	54		
7	31 4	29 56	81796	87701	94095	05905	12299	18204	53		
8	30 56	29 4	81810	87690	94120	05880	12310	18190	52		
9	30 48	29 12	81825	87679	94146	05854	12321	18175	51		
10	6 30 40	5 29 20	9 81839	9 87663	9 94171	10 05829	10 12332	10 18161	50		
11	30 32	29 12	81854	87657	94197	05803	12343	18146	49		
12	30 24	29 36	81868	87646	94222	05778	12354	18132	48		
13	30 16	29 44	81882	87635	94248	05752	12365	18118	47		
14	30 8	29 52	81897	87624	94273	05727	12376	18103	46		
15	6 30 0	5 30 0	9 81911	9 87613	9 94299	10 05701	10 12387	10 18089	45		
16	29 52	30 8	81926	87601	94324	05676	12399	18074	44		
17	29 44	30 16	81940	87590	94350	05650	12410	18060	43		
18	29 36	30 24	81955	87579	94375	05625	12421	18045	42		
19	29 28	30 32	81969	87568	94401	05599	12432	18031	41		
20	6 29 20	5 30 40	9 81983	9 87557	9 94426	10 05574	10 12443	10 18017	40		
21	29 12	30 48	81998	87546	94452	05548	12454	17998	39		
22	29 4	30 56	82012	87535	94477	05523	12465	17983	38		
23	28 56	31 4	82026	87524	94503	05497	12476	17974	37		
24	28 48	31 12	82041	87513	94528	05472	12487	17959	36		
25	6 28 40	5 31 20	9 82055	9 87501	9 94554	10 05446	10 12499	10 17945	35		
26	28 32	31 28	82069	87490	94579	05421	12510	17931	34		
27	28 24	31 36	82084	87479	94604	05396	12521	17916	33		
28	28 16	31 44	82098	87468	94630	05370	12532	17902	32		
29	28 8	31 52	82112	87457	94655	05345	12543	17888	31		
30	6 28 0	5 32 0	9 82126	9 87446	9 94681	10 05319	10 12554	10 17874	30		
31	27 52	32 0	82141	87434	94706	05294	12566	17859	29		
32	27 44	32 16	82155	87423	94732	05268	12577	17845	28		
33	27 36	32 24	82169	87412	94757	05243	12588	17831	27		
34	27 28	32 32	82184	87401	94783	05217	12599	17816	26		
35	6 27 20	5 32 40	9 82198	9 87390	9 94808	10 05192	10 12610	10 17802	25		
36	27 12	32 48	82212	87378	94834	05166	12622	17788	24		
37	27 4	32 56	82226	87367	94859	05141	12633	17774	23		
38	26 56	33 4	82240	87356	94884	05116	12644	17760	22		
39	26 48	33 12	82255	87345	94910	05090	12655	17745	21		
40	6 26 40	5 33 20	9 82269	9 87334	9 94936	10 05065	10 12666	10 17731	20		
41	26 32	33 28	82283	87322	94961	05039	12678	17717	19		
42	26 24	33 36	82297	87311	94986	05014	12689	17703	18		
43	26 16	33 44	82311	87300	95012	04988	12700	17689	17		
44	26 8	33 52	82326	87288	95037	04963	12712	17674	16		
45	6 26 0	5 34 0	9 82340	9 87277	9 95062	10 04938	10 12723	10 17660	15		
46	25 52	34 8	82354	87266	95088	04912	12734	17646	14		
47	25 44	34 16	82368	87255	95113	04887	12745	17632	13		
48	25 36	34 24	82382	87243	95139	04861	12757	17618	12		
49	25 28	34 32	82396	87232	95164	04836	12768	17604	11		
50	6 25 20	5 34 40	9 82410	9 87221	9 95190	10 04810	10 12779	10 17590	10		
51	25 12	34 48	82424	87209	95215	04785	12791	17576	9		
52	25 4	34 56	82439	87198	95240	04760	12802	17561	8		
53	24 56	35 4	82453	87187	95265	04734	12813	17547	7		
54	24 48	35 12	82467	87175	95291	04709	12825	17533	6		
55	6 24 40	5 35 20	9 82481	9 87164	9 95317	10 04683	10 12836	10 17519	5		
56	24 32	35 28	82495	87153	95342	04658	12847	17505	4		
57	24 24	35 36	82509	87141	95368	04632	12859	17491	3		
58	24 16	35 44	82523	87130	95393	04607	12870	17477	2		
59	24 8	35 52	82537	87119	95418	04582	12881	17463	1		
60	24 0	36 0	82551	87107	95443	04556	12893	17449	0		
M	Hour. M.	Hour. M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M		
131 Degs.										E	Degs. 48.

TABLE XXVII.
Log. Sines, Tangents and Secants.

Degr. 13

42 Degr.

42 Degs.									
M	HourA.M.	HourP.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	6 24 0	5 36 0	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449	
1	23 52	36 8	82565	87096	95469	04531	12904	17435	
2	23 44	36 16	82579	87085	95495	04505	12915	17421	
3	23 36	36 24	82593	87073	95520	04480	12927	17407	
4	23 28	36 32	82607	87062	95545	04455	12938	17393	
5	6 23 20	5 36 40	9.82621	9.87050	9.95571	10.04429	10.12950	10.1737	
6	23 12	36 48	82635	87039	95596	04404	12961	1736	
7	23 4	36 56	82649	87028	95622	04378	12972	1735	
8	22 56	37 4	82663	87016	95647	04353	12984	1734	
9	22 48	37 12	82677	87005	95672	04328	12995	1733	
10	6 22 40	5 37 20	9.82691	9.86993	9.95698	10.04302	10.13007	10.1731	
11	22 32	37 28	82705	86982	95723	04277	13018	1729	
12	22 24	37 36	82719	86970	95748	04252	13030	1728	
13	22 16	37 44	82733	86959	95774	04226	13041	1727	
14	22 8	37 52	82747	86947	95799	04201	13053	1726	
15	6 22 0	5 38 0	9.82761	9.86936	9.95825	10.04175	10.13064	10.1723	
16	21 52	38 8	82775	86924	95850	04150	13076	1722	
17	21 44	38 16	82788	86913	95875	04125	13087	1721	
18	21 36	38 24	82802	86902	95901	04099	13098	1719	
19	21 28	38 32	82816	86890	95926	04074	13110	1718	
20	6 21 20	5 38 40	9.82830	9.86879	9.95952	10.04048	10.13121	10.1717	
21	21 12	38 48	82844	86867	95977	04023	13133	1715	
22	21 4	38 56	82858	86855	96002	03998	13145	1714	
23	20 56	39 4	82872	86844	96028	03972	13156	1712	
24	20 48	39 12	82885	86832	96053	03947	13168	1711	
25	6 20 40	5 39 20	9.82899	9.86821	9.96078	10.03922	10.13179	10.1710	
26	20 32	39 28	82913	86809	96104	03896	13191	1708	
27	20 24	39 36	82927	86798	96129	03871	13202	1707	
28	20 16	39 44	82941	86786	96155	03845	13214	1705	
29	20 8	39 52	82955	86775	96180	03820	13225	1704	
30	6 20 0	5 40 0	9.82963	9.86763	9.96205	10.03795	10.13237	10.1703	
31	19 52	40 8	82982	86752	96231	03769	13248	1701	
32	19 44	40 16	82996	86740	96256	03744	13260	1700	
33	19 36	40 24	83010	86728	96281	03719	13272	1699	
34	19 28	40 32	83023	86717	96307	03693	13283	1697	
35	6 19 20	5 40 40	9.83037	9.86705	9.96332	10.03668	10.13295	10.1696	
36	19 12	40 48	83051	86694	96357	03643	13306	1694	
37	19 4	40 56	83065	86682	96383	03617	13318	1693	
38	18 56	41 4	83078	86670	96408	03592	13330	1692	
39	18 48	41 12	83092	86659	96433	03567	13341	1690	
40	6 18 40	5 41 20	9.83106	9.86647	9.96459	10.03541	10.13353	10.1689	
41	18 32	41 28	83120	86635	96484	03516	13365	1688	
42	18 24	41 36	83133	86624	96510	03490	13376	1687	
43	18 16	41 44	83147	86612	96535	03465	13388	1685	
44	18 8	41 52	83161	86600	96560	03440	13400	1683	
45	6 18 0	5 42 0	9.83174	9.86589	9.96586	10.03414	10.13411	10.1682	
46	17 52	42 8	83188	86577	96611	03389	13423	1681	
47	17 44	42 16	83202	86565	96636	03364	13435	1679	
48	17 36	42 24	83215	86554	96662	03338	13446	1678	
49	17 28	42 32	83229	86542	96687	03313	13458	1677	
50	6 17 20	5 42 40	9.83242	9.86530	9.96712	10.03288	10.13470	10.1675	
51	17 12	42 48	83256	86518	96738	03262	13482	1674	
52	17 4	42 56	83270	86507	96763	03237	13493	1673	
53	16 56	43 4	83283	86495	96788	03212	13505	1671	
54	16 48	43 12	83297	86483	96814	03186	13517	1670	
55	6 16 40	5 43 20	9.83310	9.86472	9.96839	10.03161	10.13528	10.1669	
56	16 32	43 28	83324	86460	96864	03136	13540	1667	
57	16 24	43 36	83338	86448	96890	03110	13552	1666	
58	16 16	43 44	83351	86436	96915	03085	13564	1664	
59	16 8	43 52	83365	86425	96940	03060	13575	1663	
60	16 0	44 0	83378	86413	96966	03034	13587	1662	
M	HourP.M.	HourA.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

132 Degr.

Degr. 47.

TABLE XXVII.

227

Log. Sines, Tangents and Secants.

43 Days.

Days 136.

M	Hour	Min.	Hour	Min.	Sine.	Co-sine.	Tangent	Co-tang.	Secant.	Co-secant	M	
0	6	16	0	5	44	0	9.83378	9.86413	9.96966	10.03034	10.16622	60
1		15	52		44	3	83392	86401	96991	03009	13599	59
2		15	44		44	16	83405	86389	97016	02984	13611	58
3		15	36		44	24	83419	86377	97042	02958	13623	57
4		15	28		44	32	83432	86366	97067	02933	13634	56
5	6	15	20	5	44	40	9.83446	9.86354	9.97092	10.02908	10.13646	55
6		15	12		44	48	83459	86342	97118	02882	13656	54
7		15	4		44	56	83473	86330	97143	02857	13670	53
8		14	56		45	4	83486	86318	97168	02832	13682	52
9		14	48		45	12	83500	86306	97193	02807	13694	51
10	6	14	40	5	45	20	9.83513	9.86295	9.97219	10.02781	10.13703	50
11		14	32		45	28	83527	86283	97244	02756	13717	49
12		14	24		45	36	83540	86271	97269	02731	13729	48
13		14	16		45	44	83554	86259	97293	02705	13741	47
14		14	8		45	52	83567	86247	97320	02680	13753	46
15	6	14	0	5	46	0	9.83581	9.86235	9.97345	10.02655	10.13765	45
16		13	52		46	8	83594	86223	97371	02629	13777	44
17		13	44		46	16	83608	86211	97396	02604	13789	43
18		13	36		46	24	83621	86200	97421	02579	13800	42
19		13	28		46	32	83634	86188	97447	02553	13812	41
20	6	13	20	5	46	40	9.83648	9.86176	9.97472	10.02529	10.13824	40
21		13	12		46	48	83661	86164	97497	02503	13836	39
22		13	4		46	56	83674	86152	97523	02477	13848	38
23		12	56		47	4	83688	86140	97548	02452	13860	37
24		12	48		47	12	83701	86128	97573	02427	13872	36
25	6	12	40	5	47	20	9.83715	9.86116	9.97598	10.02402	10.13884	35
26		12	32		47	28	83728	86104	97624	02376	13896	34
27		12	24		47	36	83741	86092	97649	02351	13908	33
28		12	16		47	44	83753	86080	97674	02326	13920	32
29		12	8		47	52	83768	86068	97700	02300	13932	31
30	6	12	0	5	48	0	9.83781	9.86056	9.97725	10.02275	10.13944	30
31		11	52		48	8	83795	86044	97750	02250	13956	29
32		11	44		48	16	83808	86032	97776	02224	13968	28
33		11	36		48	24	83821	86020	97801	02199	13980	27
34		11	28		48	32	83834	86008	97826	02174	13992	26
35	6	11	20	5	48	40	9.83848	9.85996	9.97851	10.02149	10.14004	25
36		11	12		48	48	83861	85984	97877	02123	14016	24
37		11	4		48	56	83874	85972	97902	02098	14028	23
38		10	56		49	4	83887	85960	97927	02073	14040	22
39		10	48		49	12	83901	85948	97953	02047	14052	21
40	6	10	40	5	49	20	9.83914	9.85936	9.97978	10.02023	10.14064	20
41		10	32		49	28	83927	85924	98003	01997	14076	19
42		10	24		49	36	83940	85912	98029	01971	14088	18
43		10	16		49	44	83954	85900	98054	01946	14100	17
44		10	8		49	52	83967	85888	98079	01921	14112	16
45	6	10	0	5	50	0	9.83980	9.85876	9.98104	10.01896	10.14124	15
46		9	52		50	8	83993	85864	98130	01870	14136	14
47		9	44		50	16	84006	85851	98155	01845	14148	13
48		9	36		50	24	84020	85839	98180	01820	14161	12
49		9	28		50	32	84033	85827	98206	01794	14173	11
50	6	9	20	5	50	40	9.84046	9.85815	9.98129	10.01769	10.14185	10
51		9	12		50	48	84059	85803	98256	01744	14197	9
52		9	4		50	56	84073	85791	98281	01719	14209	8
53		8	56		51	4	84086	85779	98307	01693	14221	7
54		8	48		51	12	84098	85766	98332	01668	14234	6
55	6	8	40	5	51	20	9.84112	9.85754	9.98357	10.01643	10.14246	5
56		8	32		51	28	84125	85742	98383	01617	14258	4
57		8	24		51	36	84138	85730	98408	01592	14270	3
58		8	16		51	44	84151	85718	98433	01567	14282	2
59		8	8		51	52	84164	85706	98458	01542	14294	1
60		8	0		52	0	84177	85693	98484	01516	14307	0
M	Hour	Min.	Hour	Min.	Co-sine.	Sine.	Co-tang.	Tangent	Co-secant	Secant.	M	

133 Days.

Days 46

TABLE XXVII.

Log. Sines, Tangents and Secants.

44 Degs.											Degs. 135.
M	Hour	M	Hour	Sine.	Co-sine.	Tangent	Co-tang.	Secant.	Co-secant		
0	0	0	0	9 84177	9 85503	9 92484	10 01516	10 14307	10 15823	6	
1	7	32	52 8	84190	85481	98509	01491	14319	15810	5	
2	7	44	52 16	84203	85469	98534	01466	14331	15797	4	
3	7	56	52 24	84216	85457	98560	01440	14343	15784	3	
4	7	28	52 32	84229	85445	98585	01415	14355	15771	2	
5	6	7 20	5 52 40	9 84242	9 85632	9 98610	10 01390	10 14368	10 15758	1	
6	7	12	52 48	84255	85620	98635	01365	14380	15745		
7	7	4	52 56	84269	85608	98661	01339	14392	15731		
8	6	56	53 4	84282	85596	98686	01314	14404	15718		
9	6	48	53 12	84295	85583	98711	01289	14417	15705		
10	6	6 40	5 53 20	9 84308	9 85571	9 98737	10 01263	10 14429	10 15692		
11	6	32	53 28	84321	85559	98762	01238	14441	15679		
12	6	24	53 36	84334	85547	98787	01213	14453	15666		
13	6	16	53 44	84347	85534	9 887	01188	14465	15653		
14	6	8	53 52	84360	85522	98838	01162	14478	15640		
15	6	0	5 54 0	9 84373	9 85510	9 98863	10 01137	10 14490	10 15627		
16	6	52	54 8	84385	85497	98888	01112	14503	15615		
17	6	44	54 16	84398	85485	98913	01087	14515	15602		
18	6	36	54 24	84411	85473	98939	01061	14527	15589		
19	6	28	54 32	84424	85461	98964	01036	14540	15576		
20	6	5 20	5 54 40	9 84437	9 85448	9 98989	10 01011	10 14552	10 15563		
21	6	12	54 48	84450	85436	99013	00985	14564	15550		
22	6	4	54 56	84463	85423	99040	00960	14577	15537		
23	6	56	55 4	84476	85411	99065	00935	14589	15524		
24	6	48	55 12	84489	85399	99090	00910	14601	15511		
25	6	4 40	5 55 20	9 84502	9 85386	9 99116	10 00884	10 14614	10 15498		
26	6	32	55 28	84515	85374	99141	00859	14626	15485		
27	6	24	55 36	84528	85361	99166	00834	14639	15472		
28	6	16	55 44	84540	85349	99191	00809	14651	15460		
29	6	8	55 52	84553	85337	99217	00783	14663	15447		
30	6	0	5 56 0	9 84566	9 85324	9 99242	10 00758	10 14676	10 15434		
31	6	52	56 8	84579	85312	99267	00733	14688	15421		
32	6	44	56 16	84592	85299	99293	00707	14701	15408		
33	6	36	56 24	84605	85287	99318	00682	14713	15395		
34	6	28	56 32	84618	85274	99343	00657	14726	15382		
35	6	3 20	5 56 40	9 84630	9 85262	9 99368	10 00632	10 14738	10 15370		
36	6	12	56 48	84643	85250	99394	00606	14750	15357		
37	6	4	56 56	84656	85237	99419	00581	14763	15344		
38	6	56	57 4	84669	85225	99444	00556	14775	15331		
39	6	48	57 12	84682	85212	99469	00531	14788	15318		
40	6	2 40	5 57 20	9 84694	9 85200	9 99495	10 00505	10 14790	10 15306		
41	6	32	57 28	84707	85187	99520	00480	14813	15293		
42	6	24	57 36	84720	85175	99545	00455	14825	15280		
43	6	16	57 44	84733	85162	99570	00430	14838	15267		
44	6	8	57 52	84746	85150	99596	00404	14850	15254		
45	6	0	5 58 0	9 84758	9 85137	9 99621	10 00379	10 14863	10 15242		
46	6	52	58 8	84771	85125	99646	00354	14875	15229		
47	6	44	58 16	84784	85112	99672	00328	14888	15216		
48	6	36	58 24	84796	85100	99697	00303	14900	15203		
49	6	28	58 32	84809	85087	99722	00278	14913	15190		
50	6	2 20	5 58 40	9 84822	9 85074	9 99747	10 00253	10 14926	10 15178		
51	6	12	58 48	84835	85062	99773	00227	14938	15165		
52	6	4	58 56	84847	85049	99798	00202	14951	15152		
53	6	56	59 4	84860	85037	99823	00177	14963	15139		
54	6	48	59 12	84873	85024	99848	00152	14976	15126		
55	6	0 40	5 59 20	9 84885	9 85012	9 99874	10 00126	10 14988	10 15114		
56	6	32	59 28	84898	85000	99899	00101	15001	15101		
57	6	24	59 36	84911	84986	99924	00076	15014	15088		
58	6	16	59 44	84923	84974	99949	00051	15026	15075		
59	6	8	59 52	84936	84961	99975	00025	15039	15062		
60	6	0	6 0 0	84949	84949	10 00000	00000	15051	15051		
M	Hour	M	Hour	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant		Deg.

TABLES XXVIII, XXIX.

229

TABLE XXVIII. For reducing the time of the Moon's passage over the Meridian of Greenwich to the Time of its passage over any other Meridian.
The numbers taken from this Table are to be added to the Time at Greenwich in West Longitude, but subtracted in East.

Daily variation of the Moon's passing the Meridian.

Sb's Lon.	40	42	44	46	48	50	52	54	56	58	60	62	64	66	Sb's Lon.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
10	1	1	1	1	1	1	1	1	2	2	2	2	2	2	10
15	2	2	2	2	2	2	2	2	2	2	2	3	3	3	15
20	2	2	2	3	3	3	3	3	3	3	3	3	4	4	20
25	3	3	3	3	3	3	4	4	4	4	4	4	4	5	25
30	3	3	4	4	4	4	4	4	5	5	5	5	5	5	30
35	4	4	4	4	5	5	5	5	5	6	6	6	6	6	35
40	4	5	5	5	5	6	6	6	6	6	7	7	7	7	40
45	5	5	5	6	6	6	6	7	7	7	7	8	8	8	45
50	6	6	6	6	7	7	7	7	8	8	8	9	9	9	50
55	6	6	7	7	7	8	8	8	9	9	9	9	10	10	55
60	7	7	7	8	8	8	9	9	9	10	10	10	11	11	60
65	7	8	8	8	9	9	9	10	10	10	11	11	12	12	65
70	8	8	9	9	9	10	10	10	11	11	12	12	12	13	70
75	8	9	9	10	10	10	11	11	12	12	12	13	13	14	75
80	9	9	10	10	11	11	12	12	12	13	13	14	14	15	80
85	9	10	10	11	11	12	12	13	13	14	14	15	15	16	85
90	10	10	11	11	12	12	13	13	14	14	15	15	16	16	90
95	11	11	12	12	13	13	14	14	15	15	16	16	17	17	95
100	11	12	12	13	13	14	14	15	16	16	17	17	18	18	100
105	12	12	13	13	14	15	15	16	16	17	17	18	19	19	105
110	12	13	13	14	15	15	16	16	17	18	18	19	20	20	110
115	13	13	14	15	15	16	17	17	18	19	19	20	20	21	115
120	13	14	15	15	16	17	17	18	19	19	20	21	21	22	120
125	14	15	15	16	17	17	18	19	19	20	21	22	22	23	125
130	14	15	16	17	17	18	19	19	20	21	22	22	23	23	130
135	15	16	16	17	18	19	19	20	21	22	22	23	24	25	135
140	16	16	17	18	19	19	20	21	22	23	23	24	25	26	140
145	16	17	18	19	19	20	21	22	23	23	24	25	26	27	145
150	17	17	18	19	20	21	22	22	23	24	25	26	27	27	150
155	17	18	19	20	21	22	22	23	24	25	26	27	28	28	155
160	18	19	20	20	21	22	23	24	25	26	27	28	28	29	160
165	18	19	20	21	22	23	24	25	26	27	27	28	29	30	165
170	19	20	21	22	23	24	25	25	26	27	28	29	30	31	170
175	19	20	21	22	23	24	25	26	27	28	29	30	31	32	175
180	20	21	22	23	24	25	26	27	28	29	30	31	32	33	180
40'	42'	44'	46'	48'	50'	52'	54'	56'	58'	60'	62'	64'	66'		

TABLE XXIX.
Correction of moon's altitude for Parallax and Refraction.

Alt. Deg.	Corr. Min.	Alt. Deg.	Corr. Min.
10	51	51	35
11	52	52	35
12	52	53	34
13	52	54	33
14	52	55	32
15	52	56	32
16	52	57	31
17	52	58	30
18	52	59	29
19	52	60	28
20	51		
21	51	61	27
22	51	62	26
23	51	63	26
24	50	64	25
25	50	65	25
26	50	66	23
27	49	67	22
28	49	68	21
29	49	69	20
30	48	70	19
31	47	71	18
32	47	72	17
33	47	73	17
34	46	74	16
35	46	75	15
36	45	76	14
37	45	77	13
38	44	78	12
39	44	79	11
40	43	80	10
41	42	81	9
42	42	82	8
43	41	83	7
44	40	84	6
45	40	85	5
46	39	86	4
47	38	87	3
48	38	88	2
49	37	89	1
50	36	90	0

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours																Time from Noon
	0	5	10	15	20	25	30	35	40	45	50	55	1	5	10	15	
0h 0'	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12h 0'
0 12	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1	12 12
0 24	0	0	0	0	1	1	1	1	1	1	2	2	2	0	2	2	12 24
0 36	0	0	0	1	1	1	1	2	2	2	2	3	3	0	3	3	12 36
0 48	0	1	1	1	1	2	2	2	3	3	3	4	4	0	4	4	12 48
1 0	0	1	1	2	2	2	3	3	4	4	4	5	5	0	5	5	1 0
1 12	0	1	1	2	2	3	3	4	4	5	5	6	6	0	6	6	1 12
1 24	1	1	2	2	3	3	4	5	5	6	6	7	7	0	7	7	1 24
1 36	1	1	2	3	3	4	4	5	6	6	7	7	8	0	8	8	1 36
1 48	1	1	2	3	4	4	5	5	6	7	7	8	9	0	9	9	1 48
2 0	1	2	2	3	4	5	6	6	7	7	8	9	10	0	10	10	2 0
2 12	1	2	3	4	5	6	6	7	8	9	10	11	11	0	11	11	2 12
2 24	1	2	3	4	5	6	7	8	9	10	11	12	12	0	12	12	2 24
2 36	1	2	3	4	5	6	7	8	9	10	11	12	13	0	13	13	2 36
2 48	1	2	3	5	6	7	8	9	10	11	12	13	14	0	14	14	2 48
3 0	1	2	4	5	6	7	9	10	11	12	14	15	15	0	15	15	3 0
3 12	1	3	4	5	7	8	9	11	12	13	15	16	16	0	16	16	3 12
3 24	1	3	4	6	7	8	10	11	13	14	16	17	17	0	17	17	3 24
3 36	1	3	4	6	7	9	10	12	13	15	16	18	18	0	18	18	3 36
3 48	2	3	5	6	8	9	11	13	14	16	17	19	19	0	19	19	3 48
4 0	2	3	5	7	8	10	12	13	15	17	18	20	20	0	20	20	4 0
4 12	2	3	5	7	9	10	12	14	16	17	19	21	21	0	21	21	4 12
4 24	2	4	5	7	9	11	13	15	16	18	20	22	22	0	22	22	4 24
4 36	2	4	6	8	10	11	13	15	17	19	21	23	23	0	23	23	4 36
4 48	2	4	6	8	10	12	14	16	18	20	22	24	24	0	24	24	4 48
5 0	2	4	6	8	10	12	15	17	19	21	23	25	25	0	25	25	5 0
5 12	2	4	6	9	11	13	15	17	19	22	24	26	26	0	26	26	5 12
5 24	2	4	7	9	11	13	16	18	20	22	25	27	27	0	27	27	5 24
5 36	2	5	7	9	12	14	16	19	21	23	26	28	28	0	28	28	5 36
5 48	2	5	7	10	12	14	17	19	22	24	27	29	29	0	29	29	5 48
6 0	2	5	7	10	12	15	17	20	22	25	27	30	30	0	30	30	6 0
6 12	3	5	8	10	13	15	18	21	23	26	28	31	31	0	31	31	6 12
6 24	3	5	8	11	13	16	19	21	24	27	29	32	32	0	32	32	6 24
6 36	3	5	8	11	14	16	19	22	25	27	30	33	33	0	33	33	6 36
6 48	3	6	8	11	14	17	20	23	26	28	31	34	34	0	34	34	6 48
7 0	3	6	9	12	15	17	20	23	26	29	32	35	35	0	35	35	7 0
7 12	3	6	9	12	15	18	21	24	27	30	33	36	36	0	36	36	7 12
7 24	3	6	9	12	15	18	22	25	28	31	34	37	37	0	37	37	7 24
7 36	3	6	9	13	16	19	22	25	28	32	35	38	38	0	38	38	7 36
7 48	3	6	10	13	16	19	23	26	29	32	36	39	39	0	39	39	7 48
8 0	3	7	10	13	17	20	23	27	30	33	37	40	40	0	40	40	8 0
8 12	3	7	10	14	17	20	24	27	31	34	38	41	41	0	41	41	8 12
8 24	3	7	10	14	17	21	24	28	31	35	38	42	42	0	42	42	8 24
8 36	4	7	11	14	18	21	25	29	32	36	39	43	43	0	43	43	8 36
8 48	4	7	11	15	18	22	26	29	33	37	40	44	44	0	44	44	8 48
9 0	4	7	11	15	19	22	26	30	34	37	41	45	45	0	45	45	9 0
9 12	4	8	11	15	19	23	27	31	34	38	42	46	46	0	46	46	9 12
9 24	4	8	12	16	20	23	27	31	35	39	43	47	47	0	47	47	9 24
9 36	4	8	12	16	20	24	28	32	36	40	44	48	48	0	48	48	9 36
9 48	4	8	12	16	20	24	29	33	37	41	45	49	49	0	49	49	9 48
10 0	4	8	12	17	21	25	29	33	37	42	46	50	50	0	50	50	10 0
10 12	4	8	13	17	21	25	30	34	38	42	47	51	51	0	51	51	10 12
10 24	4	9	13	17	22	26	30	35	39	43	48	52	52	0	52	52	10 24
10 36	4	9	13	18	22	26	31	35	40	44	49	53	53	0	53	53	10 36
10 48	4	9	13	18	22	27	31	36	40	45	49	54	54	0	54	54	10 48
11 0	5	9	14	18	23	27	32	37	41	46	50	55	55	1	0	55	11 0
11 12	5	9	14	19	23	28	33	37	42	47	51	56	56	1	1	56	11 12
11 24	5	9	14	19	24	28	33	38	43	47	52	57	57	1	2	57	11 24
11 36	5	10	14	19	24	29	34	39	44	48	53	58	58	1	3	58	11 36
11 48	5	10	15	20	25	29	34	39	44	49	54	59	59	1	4	59	11 48
12 0	5	10	15	20	25	30	35	40	45	50	55	60	60	1	5	60	12 0

TABLE XXX.

231

For reducing the Moon's Declination as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon	Variation of the Moon's Declination in twelve Hours										Time from Noon
	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45	1 50	1 55	
0h 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	12h 0
0 12	0 1	0 1	0 1	0 1	0 1	0 2	0 2	0 2	0 2	0 2	12 12
0 24	0 2	0 2	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	12 24
0 36	0 3	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 6	12 36
0 48	0 3	0 5	0 5	0 6	0 6	0 6	0 7	0 7	0 7	0 8	12 48
1 0	0 6	0 6	0 7	0 7	0 7	0 8	0 8	0 9	0 9	0 10	13 0
1 12	0 7	0 7	0 8	0 8	0 9	0 9	0 10	0 10	0 11	0 11	13 12
1 24	0 8	0 9	0 9	0 10	0 10	0 11	0 12	0 12	0 13	0 13	13 24
1 36	0 9	0 10	0 11	0 11	0 12	0 13	0 13	0 14	0 15	0 15	13 36
1 48	0 10	0 11	0 12	0 13	0 13	0 14	0 15	0 16	0 16	0 17	13 48
2 0	0 12	0 12	0 13	0 14	0 15	0 16	0 17	0 17	0 18	0 19	14 0
2 12	0 13	0 14	0 15	0 16	0 16	0 17	0 18	0 19	0 20	0 21	14 12
2 24	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 22	0 23	14 24
2 36	0 15	0 16	0 17	0 18	0 19	0 21	0 22	0 23	0 24	0 25	14 36
2 48	0 16	0 17	0 19	0 20	0 21	0 22	0 23	0 24	0 26	0 27	14 48
3 0	0 17	0 19	0 20	0 21	0 22	0 24	0 25	0 26	0 27	0 29	15 0
3 12	0 19	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 29	0 31	15 12
3 24	0 20	0 21	0 23	0 24	0 25	0 27	0 29	0 30	0 31	0 33	15 24
3 36	0 21	0 22	0 24	0 25	0 27	0 28	0 30	0 31	0 33	0 34	15 36
3 48	0 22	0 24	0 25	0 27	0 28	0 30	0 32	0 33	0 35	0 36	15 48
4 0	0 23	0 25	0 27	0 28	0 30	0 32	0 34	0 35	0 37	0 38	16 0
4 12	0 24	0 26	0 28	0 30	0 31	0 33	0 35	0 37	0 38	0 40	16 12
4 24	0 26	0 27	0 29	0 31	0 33	0 35	0 37	0 39	0 40	0 42	16 24
4 36	0 27	0 29	0 31	0 33	0 34	0 36	0 38	0 40	0 42	0 44	16 36
4 48	0 28	0 30	0 32	0 34	0 36	0 38	0 40	0 42	0 44	0 46	16 48
5 0	0 29	0 31	0 33	0 35	0 37	0 40	0 42	0 44	0 46	0 48	17 0
5 12	0 30	0 32	0 35	0 37	0 39	0 41	0 43	0 45	0 48	0 50	17 12
5 24	0 31	0 34	0 36	0 38	0 40	0 43	0 45	0 47	0 49	0 52	17 24
5 36	0 33	0 35	0 37	0 40	0 42	0 44	0 47	0 49	0 51	0 54	17 36
5 48	0 34	0 36	0 39	0 41	0 43	0 46	0 48	0 51	0 53	0 56	17 48
6 0	0 35	0 37	0 40	0 42	0 45	0 47	0 50	0 52	0 55	0 57	18 0
6 12	0 37	0 39	0 41	0 44	0 46	0 49	0 52	0 54	0 57	0 59	18 12
6 24	0 37	0 40	0 43	0 45	0 48	0 51	0 53	0 56	0 59	1 1	18 24
6 36	0 38	0 41	0 44	0 47	0 49	0 52	0 55	0 58	1 0	1 3	18 36
6 48	0 40	0 42	0 45	0 48	0 51	0 54	0 57	0 59	1 2	1 5	18 48
7 0	0 41	0 44	0 47	0 50	0 52	0 55	0 58	1 1	1 4	1 7	19 0
7 12	0 42	0 45	0 48	0 51	0 54	0 57	1 0	1 3	1 6	1 9	19 12
7 24	0 43	0 46	0 49	0 52	0 55	0 59	1 2	1 5	1 8	1 11	19 24
7 36	0 44	0 47	0 51	0 54	0 57	1 0	1 3	1 6	1 10	1 13	19 36
7 48	0 45	0 49	0 52	0 55	0 58	1 2	1 5	1 8	1 11	1 15	19 48
8 0	0 47	0 50	0 53	0 57	1 0	1 3	1 7	1 10	1 13	1 17	20 0
8 12	0 48	0 51	0 55	0 58	1 1	1 5	1 8	1 12	1 15	1 19	20 12
8 24	0 49	0 52	0 56	0 59	1 3	1 6	1 10	1 13	1 17	1 22	20 24
8 36	0 50	0 54	0 57	1 1	1 4	1 8	1 12	1 15	1 19	1 22	20 36
8 48	0 51	0 55	0 59	1 2	1 6	1 10	1 13	1 17	1 21	1 24	20 48
9 0	0 52	0 56	1 0	1 4	1 7	1 11	1 15	1 19	1 23	1 26	21 0
9 12	0 54	0 57	1 1	1 5	1 9	1 13	1 17	1 20	1 24	1 28	21 12
9 24	0 55	0 59	1 3	1 7	1 10	1 14	1 18	1 22	1 26	1 30	21 24
9 36	0 56	1 0	1 4	1 8	1 12	1 16	1 20	1 24	1 28	1 32	21 36
9 48	0 57	1 1	1 5	1 9	1 13	1 18	1 22	1 26	1 30	1 34	21 48
10 0	0 58	1 2	1 7	1 11	1 15	1 19	1 23	1 27	1 32	1 36	22 0
10 12	0 59	1 4	1 8	1 12	1 16	1 21	1 25	1 29	1 33	1 38	22 12
10 24	1 1	1 5	1 9	1 14	1 18	1 22	1 27	1 31	1 35	1 40	22 24
10 36	1 2	1 6	1 11	1 15	1 19	1 24	1 28	1 33	1 37	1 42	22 36
10 48	1 3	1 7	1 12	1 16	1 21	1 25	1 30	1 34	1 39	1 43	22 48
11 0	1 4	1 9	1 13	1 17	1 22	1 27	1 32	1 36	1 41	1 45	23 0
11 12	1 5	1 10	1 15	1 19	1 24	1 29	1 34	1 38	1 43	1 47	23 12
11 24	1 6	1 11	1 16	1 21	1 25	1 30	1 35	1 40	1 44	1 49	23 24
11 36	1 8	1 12	1 17	1 22	1 27	1 32	1 37	1 41	1 46	1 51	23 36
11 48	1 9	1 14	1 19	1 24	1 29	1 33	1 38	1 43	1 48	1 53	23 48
12 0	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45	1 50	1 55	24 0

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours												Time from Noon.
	0 0	0 5	0 10	0 15	0 20	0 25	0 30	0 35	0 40	0 45	0 50		
0h 0'	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	12h 0'	
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 3	0 3	0 3	0 3	12 12	
0 24	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 5	0 5	0 6	12 24	
0 36	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 8	0 8	0 8	0 8	12 36	
0 48	0 8	0 8	0 9	0 9	0 9	0 10	0 10	0 10	0 11	0 11	0 11	12 48	
1 0	0 10	0 10	0 11	0 11	0 12	0 12	0 12	0 13	0 13	0 14	0 14	13 0	
1 12	0 12	0 12	0 13	0 13	0 14	0 14	0 15	0 15	0 16	0 16	0 17	13 12	
1 24	0 14	0 15	0 15	0 16	0 16	0 17	0 17	0 18	0 19	0 19	0 20	13 24	
1 36	0 16	0 17	0 17	0 18	0 19	0 19	0 20	0 21	0 21	0 22	0 23	13 36	
1 48	0 18	0 19	0 19	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 25	13 48	
2 0	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	14 0	
2 12	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	0 29	0 30	0 31	14 12	
2 24	0 24	0 25	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 33	0 34	14 24	
2 36	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 34	0 35	0 36	0 37	14 36	
2 48	0 28	0 29	0 30	0 31	0 33	0 34	0 35	0 36	0 37	0 38	0 40	14 48	
3 0	0 30	0 31	0 32	0 34	0 35	0 36	0 37	0 39	0 40	0 41	0 42	15 0	
3 12	0 32	0 33	0 35	0 36	0 37	0 39	0 40	0 41	0 43	0 44	0 45	15 12	
3 24	0 34	0 35	0 37	0 38	0 40	0 41	0 42	0 44	0 45	0 47	0 48	15 24	
3 36	0 36	0 37	0 39	0 40	0 42	0 43	0 45	0 46	0 48	0 49	0 51	15 36	
3 48	0 38	0 40	0 41	0 43	0 44	0 46	0 47	0 49	0 51	0 52	0 54	15 48	
4 0	0 40	0 42	0 44	0 45	0 47	0 48	0 50	0 52	0 53	0 55	0 57	16 0	
4 12	0 42	0 44	0 45	0 47	0 49	0 51	0 52	0 54	0 56	0 58	0 59	16 12	
4 24	0 44	0 46	0 48	0 49	0 51	0 53	0 55	0 57	0 59	1 0	1 2	16 24	
4 36	0 46	0 48	0 50	0 52	0 54	0 56	0 57	0 59	1 1	1 3	1 5	16 36	
4 48	0 48	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 4	1 6	1 8	16 48	
5 0	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 5	1 7	1 9	1 11	17 0	
5 12	0 52	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 9	1 11	1 14	17 12	
5 24	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 10	1 12	1 14	1 16	17 24	
5 36	0 56	0 58	1 1	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 19	17 36	
5 48	0 58	1 0	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 20	1 22	17 48	
6 0	1 0	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 22	1 25	18 0	
6 12	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 23	1 25	1 28	18 12	
6 24	1 4	1 7	1 9	1 12	1 15	1 17	1 20	1 23	1 25	1 28	1 31	18 24	
6 36	1 6	1 9	1 11	1 14	1 17	1 20	1 22	1 25	1 28	1 31	1 33	18 36	
6 48	1 8	1 11	1 14	1 16	1 19	1 22	1 25	1 28	1 31	1 33	1 36	18 48	
7 0	1 10	1 13	1 16	1 19	1 22	1 25	1 27	1 30	1 33	1 36	1 39	19 0	
7 12	1 12	1 15	1 18	1 21	1 24	1 27	1 30	1 33	1 36	1 39	1 42	19 12	
7 24	1 14	1 17	1 20	1 23	1 26	1 29	1 32	1 36	1 39	1 42	1 45	19 24	
7 36	1 16	1 19	1 22	1 25	1 29	1 32	1 35	1 38	1 41	1 44	1 48	19 36	
7 48	1 18	1 21	1 24	1 28	1 31	1 34	1 37	1 41	1 44	1 47	1 50	19 48	
8 0	1 20	1 23	1 27	1 30	1 33	1 37	1 40	1 43	1 47	1 50	1 53	20 0	
8 12	1 22	1 25	1 29	1 32	1 36	1 39	1 42	1 46	1 49	1 53	1 56	20 12	
8 24	1 24	1 27	1 31	1 34	1 38	1 41	1 45	1 48	1 52	1 55	1 59	20 24	
8 36	1 26	1 30	1 33	1 37	1 40	1 44	1 47	1 51	1 54	1 58	2 0	20 36	
8 48	1 28	1 32	1 35	1 39	1 43	1 46	1 50	1 54	1 57	2 1	2 5	20 48	
9 0	1 30	1 34	1 37	1 41	1 45	1 49	1 52	1 56	2 0	2 4	2 7	21 0	
9 12	1 32	1 36	1 40	1 43	1 47	1 51	1 55	1 59	2 3	2 6	2 10	21 12	
9 24	1 34	1 38	1 42	1 46	1 50	1 54	1 57	2 1	2 5	2 9	2 13	21 24	
9 36	1 36	1 40	1 44	1 48	1 52	1 56	2 0	2 4	2 8	2 12	2 16	21 36	
9 48	1 38	1 42	1 46	1 50	1 54	1 58	2 2	2 7	2 11	2 15	2 19	21 48	
10 0	1 40	1 44	1 48	1 52	1 57	2 1	2 5	2 9	2 13	2 17	2 22	22 0	
10 12	1 42	1 46	1 50	1 55	2 0	2 4	2 8	2 12	2 16	2 20	2 24	22 12	
10 24	1 44	1 48	1 53	1 57	2 1	2 6	2 10	2 14	2 19	2 23	2 27	22 24	
10 36	1 46	1 50	1 55	1 59	2 4	2 9	2 13	2 17	2 21	2 26	2 30	22 36	
10 48	1 48	1 52	1 57	2 1	2 6	2 10	2 15	2 19	2 24	2 28	2 33	22 48	
11 0	1 50	1 55	1 59	2 4	2 9	2 13	2 17	2 22	2 27	2 31	2 36	23 0	
11 12	1 52	1 57	2 1	2 6	2 11	2 15	2 20	2 25	2 29	2 34	2 39	23 12	
11 24	1 54	1 59	2 3	2 8	2 13	2 18	2 23	2 27	2 32	2 37	2 41	23 24	
11 36	1 56	2 1	2 6	2 10	2 15	2 20	2 25	2 30	2 35	2 39	2 44	23 36	
11 48	1 58	2 3	2 8	2 13	2 18	2 23	2 27	2 32	2 37	2 42	2 47	23 48	
12 0	2 0	2 5	2 10	2 15	2 20	2 25	2 30	2 35	2 40	2 45	2 50	24 0	

TABLE XXX.

233

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon	Variation of the Moon's Declination in twelve Hours.												Time from Noon
	2 55	3 0	3 5	3 10	3 15	3 20	3 25	3 30	3 35	3 40	3 45		
0h 0'	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	12h 0'	
0 12	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	0 4	12 12	
0 24	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 7	0 7	12 24	
0 36	0 9	0 9	0 9	0 9	0 10	0 10	0 10	0 10	0 11	0 11	0 11	12 36	
0 48	0 12	0 12	0 12	0 13	0 13	0 13	0 14	0 14	0 14	0 15	0 15	12 48	
1 0	0 15	0 15	0 15	0 16	0 16	0 17	0 17	0 17	0 18	0 18	0 19	13 0	
1 12	0 17	0 18	0 18	0 19	0 19	0 20	0 20	0 21	0 21	0 22	0 22	13 12	
1 24	0 20	0 21	0 22	0 22	0 23	0 23	0 24	0 24	0 25	0 25	0 26	13 24	
1 36	0 23	0 24	0 25	0 25	0 26	0 27	0 27	0 28	0 29	0 29	0 30	13 36	
1 48	0 26	0 27	0 28	0 28	0 29	0 30	0 31	0 31	0 32	0 33	0 34	13 48	
2 0	0 29	0 30	0 31	0 32	0 32	0 33	0 34	0 35	0 36	0 37	0 37	14 0	
2 12	0 32	0 33	0 34	0 35	0 36	0 37	0 38	0 38	0 39	0 40	0 41	14 12	
2 24	0 35	0 36	0 37	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	14 24	
2 36	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	14 36	
2 48	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	0 50	0 51	0 52	14 48	
3 0	0 44	0 45	0 46	0 47	0 49	0 50	0 51	0 52	0 54	0 55	0 56	15 0	
3 12	0 47	0 48	0 49	0 51	0 52	0 53	0 55	0 56	0 57	0 59	1 0	15 12	
3 24	0 50	0 51	0 52	0 54	0 55	0 57	0 58	0 59	1 1	1 2	1 4	15 24	
3 36	0 52	0 54	0 55	0 57	0 58	1 0	1 1	1 3	1 4	1 6	1 7	15 36	
3 48	0 55	0 57	0 59	1 0	1 2	1 3	1 5	1 6	1 8	1 10	1 11	15 48	
4 0	0 58	1 0	1 2	1 3	1 5	1 7	1 8	1 10	1 12	1 13	1 15	16 0	
4 12	1 1	1 3	1 5	1 6	1 8	1 10	1 12	1 13	1 15	1 17	1 19	16 12	
4 24	1 4	1 6	1 8	1 10	1 11	1 13	1 15	1 17	1 19	1 21	1 22	16 24	
4 36	1 7	1 9	1 11	1 13	1 15	1 17	1 19	1 21	1 22	1 24	1 26	16 36	
4 48	1 10	1 12	1 14	1 16	1 18	1 20	1 22	1 24	1 26	1 28	1 30	16 48	
5 0	1 13	1 15	1 17	1 19	1 21	1 23	1 25	1 27	1 30	1 32	1 34	17 0	
5 12	1 16	1 18	1 20	1 22	1 24	1 27	1 29	1 31	1 33	1 35	1 37	17 12	
5 24	1 19	1 21	1 23	1 25	1 28	1 30	1 32	1 34	1 37	1 39	1 41	17 24	
5 36	1 22	1 24	1 26	1 29	1 31	1 33	1 36	1 38	1 40	1 43	1 45	17 36	
5 48	1 25	1 27	1 29	1 32	1 34	1 37	1 39	1 41	1 44	1 46	1 49	17 48	
6 0	1 27	1 30	1 32	1 35	1 37	1 40	1 42	1 45	1 47	1 50	1 52	18 0	
6 12	1 30	1 33	1 36	1 38	1 41	1 43	1 46	1 48	1 51	1 54	1 56	18 12	
6 24	1 33	1 36	1 39	1 41	1 44	1 47	1 49	1 52	1 55	1 57	2 0	18 24	
6 36	1 36	1 39	1 42	1 44	1 47	1 50	1 53	1 55	1 58	2 1	2 4	18 36	
6 48	1 39	1 42	1 45	1 48	1 50	1 53	1 56	1 59	2 2	2 5	2 7	18 48	
7 0	1 42	1 45	1 48	1 51	1 54	1 57	2 0	2 2	2 5	2 8	2 11	19 0	
7 12	1 45	1 48	1 51	1 54	1 57	2 0	2 3	2 5	2 9	2 12	2 15	19 12	
7 24	1 48	1 51	1 54	1 57	2 0	2 3	2 6	2 9	2 13	2 16	2 19	19 24	
7 36	1 51	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 19	2 22	19 36	
7 48	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 20	2 23	2 26	19 48	
8 0	1 57	2 0	2 3	2 7	2 10	2 13	2 17	2 20	2 23	2 27	2 30	20 0	
8 12	2 0	2 3	2 6	2 10	2 13	2 17	2 20	2 23	2 27	2 30	2 34	20 12	
8 24	2 2	2 6	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 37	20 24	
8 36	2 5	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 38	2 41	20 36	
8 48	2 8	2 12	2 16	2 19	2 23	2 27	2 30	2 34	2 38	2 41	2 45	20 48	
9 0	2 11	2 15	2 19	2 22	2 26	2 30	2 34	2 37	2 41	2 45	2 49	21 0	
9 12	2 14	2 18	2 22	2 26	2 29	2 33	2 37	2 41	2 45	2 49	2 52	21 12	
9 24	2 17	2 21	2 25	2 29	2 33	2 37	2 41	2 44	2 48	2 52	2 56	21 24	
9 36	2 20	2 24	2 28	2 32	2 36	2 40	2 44	2 48	2 52	2 56	3 0	21 36	
9 48	2 23	2 27	2 31	2 35	2 39	2 43	2 47	2 51	2 56	3 0	3 4	21 48	
10 0	2 26	2 30	2 34	2 38	2 42	2 47	2 51	2 55	2 59	3 3	3 7	22 0	
10 12	2 29	2 33	2 37	2 41	2 46	2 50	2 54	2 58	3 3	3 7	3 11	22 12	
10 24	2 32	2 36	2 40	2 45	2 49	2 53	2 58	3 2	3 6	3 11	3 15	22 24	
10 36	2 35	2 39	2 43	2 48	2 52	2 57	3 1	3 5	3 10	3 14	3 19	22 36	
10 48	2 37	2 42	2 46	2 51	2 56	3 0	3 4	3 9	3 13	3 18	3 22	22 48	
11 0	2 40	2 45	2 50	2 54	2 59	3 3	3 8	3 12	3 17	3 22	3 26	23 0	
11 12	2 43	2 48	2 53	2 57	3 2	3 7	3 11	3 16	3 21	3 25	3 30	23 12	
11 24	2 46	2 51	2 56	3 0	3 5	3 10	3 15	3 19	3 24	3 29	3 34	23 24	
11 36	2 49	2 54	2 59	3 4	3 8	3 13	3 18	3 23	3 28	3 33	3 37	23 36	
11 48	2 52	2 57	3 2	3 7	3 12	3 17	3 22	3 26	3 31	3 36	3 41	23 48	
12 0	2 55	3 0	3 5	3 10	3 15	3 20	3 25	3 30	3 35	3 40	3 45	24 0	

TABLE XXXI.

235

For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other time under any other Meridian.

Time from Noon	Daily Variation of the Sun's Right Ascension in Time.										Ship's Long.
	3 48	3 50	3 52	3 54	3 56	3 58	4 0	4 2	4 4	4 6	
0h 0'	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3
0 24	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6
0 36	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	9
0 48	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	12
1 0	0 9	0 10	0 10	0 10	0 10	0 10	0 10	0 10	0 10	0 10	15
1 12	0 11	0 11	0 12	0 12	0 12	0 12	0 12	0 12	0 12	0 12	18
1 24	0 13	0 13	0 14	0 14	0 14	0 14	0 14	0 14	0 14	0 14	21
1 36	0 15	0 15	0 15	0 16	0 16	0 16	0 16	0 16	0 16	0 16	24
1 48	0 17	0 17	0 17	0 18	0 18	0 18	0 18	0 18	0 18	0 18	27
2 0	0 19	0 19	0 19	0 19	0 20	0 20	0 20	0 20	0 20	0 20	30
2 12	0 21	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	0 22	33
2 24	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	0 24	36
2 36	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	0 26	0 26	39
2 48	0 27	0 27	0 27	0 27	0 28	0 28	0 28	0 28	0 28	0 28	42
3 0	0 28	0 29	0 29	0 29	0 29	0 30	0 30	0 30	0 30	0 31	45
3 12	0 30	0 31	0 31	0 31	0 31	0 32	0 32	0 32	0 32	0 33	48
3 24	0 32	0 33	0 33	0 33	0 33	0 34	0 34	0 34	0 34	0 35	51
3 36	0 34	0 34	0 35	0 35	0 35	0 36	0 36	0 36	0 37	0 37	54
3 48	0 36	0 36	0 37	0 37	0 37	0 38	0 38	0 38	0 39	0 39	57
4 0	0 38	0 38	0 39	0 39	0 39	0 40	0 40	0 40	0 41	0 41	60
4 12	0 40	0 40	0 41	0 41	0 41	0 42	0 42	0 42	0 43	0 43	63
4 24	0 42	0 42	0 43	0 43	0 43	0 44	0 44	0 44	0 45	0 45	66
4 36	0 44	0 44	0 44	0 45	0 45	0 46	0 46	0 46	0 47	0 47	69
4 48	0 46	0 46	0 46	0 47	0 47	0 48	0 48	0 48	0 49	0 49	72
5 0	0 47	0 48	0 48	0 49	0 49	0 50	0 50	0 50	0 51	0 51	75
5 12	0 49	0 50	0 50	0 51	0 51	0 52	0 52	0 52	0 53	0 53	78
5 24	0 51	0 52	0 52	0 53	0 53	0 54	0 54	0 54	0 55	0 55	81
5 36	0 53	0 54	0 54	0 55	0 55	0 56	0 56	0 56	0 57	0 57	84
5 48	0 55	0 56	0 56	0 57	0 57	0 58	0 58	0 58	0 59	0 59	87
6 0	0 57	0 57	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	90
6 12	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 3	1 3	1 4	93
6 24	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 5	1 5	1 6	96
6 36	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 7	1 7	1 8	99
6 48	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 9	1 9	1 10	102
7 0	1 6	1 7	1 8	1 8	1 9	1 9	1 10	1 11	1 11	1 12	105
7 12	1 8	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	1 14	108
7 24	1 10	1 11	1 12	1 12	1 13	1 13	1 14	1 15	1 15	1 16	111
7 36	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 17	1 17	1 18	114
7 48	1 14	1 15	1 15	1 16	1 17	1 17	1 18	1 19	1 19	1 20	117
8 0	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 21	1 21	1 22	120
8 12	1 18	1 19	1 19	1 20	1 21	1 21	1 22	1 23	1 23	1 24	123
8 24	1 20	1 20	1 21	1 22	1 23	1 23	1 24	1 25	1 25	1 26	126
8 36	1 22	1 22	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	129
8 48	1 24	1 24	1 25	1 26	1 27	1 27	1 28	1 29	1 29	1 30	132
9 0	1 25	1 26	1 27	1 28	1 28	1 29	1 30	1 31	1 31	1 32	135
9 12	1 27	1 28	1 29	1 30	1 30	1 31	1 32	1 33	1 34	1 34	138
9 24	1 29	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 36	1 36	141
9 36	1 31	1 32	1 33	1 34	1 34	1 35	1 36	1 37	1 38	1 38	144
9 48	1 33	1 34	1 35	1 36	1 36	1 37	1 38	1 39	1 40	1 40	147
10 0	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 41	1 42	1 42	150
10 12	1 37	1 38	1 39	1 39	1 40	1 41	1 42	1 43	1 44	1 44	153
10 24	1 39	1 40	1 41	1 41	1 42	1 43	1 44	1 45	1 46	1 47	156
10 36	1 41	1 42	1 42	1 43	1 44	1 45	1 46	1 47	1 48	1 49	159
10 48	1 43	1 43	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	162
11 0	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	165
11 12	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	168
11 24	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	171
11 36	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	174
11 48	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	177
12 0	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	180
	3 48	3 50	3 52	3 54	3 56	3 58	4 0	4 2	4 4	4 6	

For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other time under any other Meridian.

Time from Noon.	Daily Variation of the Sun's Right Ascension in Time.												Ship's Long.
	4 8	4 10	4 12	4 14	4 16	4 18	4 20	4 22	4 24	4 26	4 28		
0h 0'	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0°	
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3	
0 24	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6	
0 36	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	9	
0 48	0 8	0 8	0 8	0 8	0 9	0 9	0 9	0 9	0 9	0 9	0 9	12	
1 0	0 10	0 10	0 10	0 11	0 11	0 11	0 11	0 11	0 11	0 11	0 11	15	
1 12	0 12	0 12	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	18	
1 24	0 14	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 16	0 16	21	
1 36	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 18	0 18	0 18	24	
1 48	0 19	0 19	0 19	0 19	0 19	0 19	0 19	0 20	0 20	0 20	0 20	27	
2 0	0 21	0 21	0 21	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	30	
2 12	0 23	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	0 25	33	
2 24	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	0 26	0 27	0 27	36	
2 36	0 27	0 27	0 27	0 28	0 28	0 28	0 28	0 28	0 29	0 29	0 29	39	
2 48	0 29	0 29	0 29	0 30	0 30	0 30	0 30	0 31	0 31	0 31	0 31	42	
3 0	0 31	0 31	0 31	0 32	0 32	0 32	0 32	0 33	0 33	0 33	0 33	45	
3 12	0 33	0 33	0 34	0 34	0 34	0 34	0 35	0 35	0 35	0 35	0 36	48	
3 24	0 35	0 35	0 36	0 36	0 36	0 37	0 37	0 37	0 37	0 38	0 38	51	
3 36	0 37	0 37	0 38	0 38	0 38	0 39	0 39	0 39	0 40	0 40	0 40	54	
3 48	0 39	0 40	0 40	0 40	0 41	0 41	0 41	0 41	0 42	0 42	0 42	57	
4 0	0 41	0 42	0 42	0 42	0 43	0 43	0 43	0 44	0 44	0 44	0 45	60	
4 12	0 43	0 44	0 44	0 44	0 45	0 45	0 45	0 46	0 46	0 47	0 47	63	
4 24	0 45	0 46	0 46	0 47	0 47	0 47	0 48	0 48	0 48	0 49	0 49	66	
4 36	0 48	0 48	0 48	0 49	0 49	0 49	0 50	0 50	0 51	0 51	0 51	69	
4 48	0 50	0 50	0 50	0 51	0 51	0 52	0 52	0 52	0 53	0 53	0 54	72	
5 0	0 52	0 52	0 52	0 53	0 53	0 54	0 54	0 55	0 55	0 55	0 56	75	
5 12	0 54	0 54	0 55	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58	78	
5 24	0 56	0 56	0 57	0 57	0 58	0 58	0 58	0 59	0 59	1 0	1 0	81	
5 36	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 2	1 3	84	
5 48	1 0	1 0	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 4	1 5	87	
6 0	1 2	1 2	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	1 7	90	
6 12	1 4	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 8	1 9	1 9	93	
6 24	1 6	1 7	1 7	1 8	1 8	1 9	1 9	1 10	1 10	1 11	1 11	96	
6 36	1 8	1 9	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	1 14	99	
6 48	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 14	1 15	1 15	1 16	102	
7 0	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 16	1 17	1 18	1 18	105	
7 12	1 14	1 15	1 16	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 20	108	
7 24	1 16	1 17	1 18	1 18	1 19	1 20	1 20	1 21	1 21	1 22	1 23	111	
7 36	1 19	1 19	1 20	1 20	1 21	1 22	1 22	1 23	1 24	1 24	1 25	114	
7 48	1 21	1 21	1 22	1 23	1 23	1 24	1 24	1 25	1 26	1 26	1 27	117	
8 0	1 23	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 29	120	
8 12	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	123	
8 24	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	126	
8 36	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	129	
8 48	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	1 37	1 38	1 38	132	
9 0	1 33	1 34	1 34	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	135	
9 12	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	1 41	1 42	1 43	138	
9 24	1 37	1 38	1 39	1 39	1 40	1 41	1 42	1 43	1 43	1 44	1 45	141	
9 36	1 39	1 40	1 41	1 42	1 42	1 43	1 44	1 45	1 46	1 46	1 47	144	
9 48	1 41	1 42	1 43	1 44	1 45	1 45	1 46	1 47	1 48	1 49	1 49	147	
10 0	1 43	1 44	1 45	1 46	1 47	1 47	1 48	1 49	1 50	1 51	1 52	150	
10 12	1 45	1 46	1 47	1 48	1 49	1 50	1 50	1 51	1 52	1 53	1 54	153	
10 24	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 54	1 55	1 56	156	
10 36	1 50	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 57	1 58	159	
10 48	1 52	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	162	
11 0	1 54	1 55	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	165	
11 12	1 56	1 57	1 58	1 59	1 59	2 0	2 1	2 2	2 3	2 4	2 5	168	
11 24	1 58	1 59	2 0	2 1	2 2	2 3	2 3	2 4	2 5	2 6	2 7	171	
11 36	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	174	
11 48	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	177	
12 0	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 13	2 14	180	
	4 8"	4 10"	4 12"	4 14"	4 16"	4 18"	4 20"	4 22"	4 24"	4 26"	4 28"		

TABLE XXXII.

237

Variation of the Sun's Altitude in one minute from noon.

Lat.	Declination of a different name from the latitude												Lat.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
0°					28.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0°
1				28.1	22.4	18.7	16.0	14.0	12.4	11.2	10.1	9.3	1
2			28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	2
3		28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	3
4	28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	4
5	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	7.0	5
6	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6
7	16.0	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	7
8	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	8
9	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	5.6	9
10	11.1	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	10
11	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	5.1	11
12	9.2	8.6	7.9	7.4	7.0	6.5	6.2	5.9	5.6	5.3	5.0	4.8	12
13	8.5	7.9	7.4	6.9	6.5	6.2	5.9	5.6	5.3	5.0	4.7	4.6	13
14	7.9	7.4	6.9	6.5	6.2	5.8	5.5	5.3	5.0	4.7	4.6	4.4	14
15	7.3	6.9	6.5	6.1	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	15
16	6.8	6.5	6.1	5.8	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	16
17	6.4	6.1	5.8	5.5	5.2	4.9	4.8	4.6	4.4	4.2	4.1	3.9	17
18	6.0	5.7	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	18
19	5.7	5.4	5.2	4.9	4.7	4.5	4.4	4.2	4.0	3.9	3.8	3.6	19
20	5.4	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.7	3.6	3.5	20
21	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.7	3.6	3.5	3.4	21
22	4.9	4.7	4.5	4.3	4.1	4.0	3.9	3.7	3.6	3.5	3.4	3.3	22
23	4.6	4.4	4.3	4.1	4.0	3.8	3.7	3.6	3.5	3.4	3.3	3.2	23
24	4.4	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.1	24
25	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.1	3.0	25
26	4.0	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	3.0	3.0	2.9	26
27	3.9	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	27
28	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	28
29	3.5	3.4	3.3	3.2	3.1	3.1	3.0	2.9	2.8	2.8	2.7	2.6	29
30	3.4	3.3	3.2	3.1	3.0	3.0	2.9	2.8	2.7	2.7	2.6	2.5	30
31	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.5	31
32	3.1	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	32
33	3.0	2.9	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	33
34	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	34
35	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	35
36	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	36
37	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.2	2.1	2.1	37
38	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	38
39	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	2.0	39
40	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	40
41	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	41
42	2.2	2.1	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	42
43	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	43
44	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	44
45	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	45
46	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	46
47	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	47
48	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.5	1.5	48
49	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	49
50	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	50
52	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	52
54	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	54
56	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	56
58	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	58
60	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	60
62	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	62
64	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	64
66	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	66
68	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	68
70	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	70
0	1	2	3	4	5	6	7	8	9	10	11		

TABLE XXII

TABLE XXXII.
Variation of the Sun's Altitude in one minute from noon.

Declination of a different name from the Latitude.														
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
Lat.	"	"	"	"	"	"	"	"	"	"	"	"	"	Lat.
0	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0
1	8.5	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5.1	4.9	4.7	4.4	4.2	1
2	7.9	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	2
3	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	3.9	3
4	7.0	6.5	6.2	5.8	5.5	5.2	5.0	4.7	4.5	4.3	4.1	4.0	3.8	4
5	6.5	6.2	5.8	5.5	5.2	5.0	4.8	4.5	4.3	4.2	4.0	3.8	3.7	5
6	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	6
7	5.9	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	7
8	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	3.4	8
9	5.3	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	9
10	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	10
11	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	11
12	4.6	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	12
13	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	13
14	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	14
15	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	15
16	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	16
17	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	17
18	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.5	18
19	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	19
20	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.4	20
21	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	21
22	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	22
23	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.3	23
24	3.0	2.9	2.8	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.3	24
25	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	25
26	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.1	2.1	26
27	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.1	27
28	2.6	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	28
29	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	29
30	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	30
31	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	31
32	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	32
33	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	33
34	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	34
35	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	35
36	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	36
37	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	37
38	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	38
39	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	39
40	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	40
41	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	41
42	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	42
43	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	43
44	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	44
45	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	45
46	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	46
47	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	47
48	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	48
49	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	49
50	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	50
51	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	51
52	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	52
53	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	53
54	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	54
55	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	55
56	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	56
57	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	57
58	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	58
59	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	59
60	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	60
61	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	61

TABLE XXXII.

239

Variation of the Sun's Altitude in one minute from noon.

Lat.	Declination of the same name as the latitude.												Lat.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
0°					29.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0°
1						28.0	22.4	18.6	16.0	13.9	12.4	11.1	1
2							28.0	22.3	18.6	15.9	13.9	12.3	2
3								27.9	22.3	18.5	15.8	13.8	3
4	28.1								27.8	22.2	18.5	15.8	4
5	22.4	28.0								27.7	22.1	18.4	5
6	18.7	22.4	28.0								27.6	22.0	6
7	16.0	18.6	22.3	27.9								27.4	7
8	14.0	16.0	18.6	22.3	27.8								8
9	12.4	13.9	15.9	18.5	22.2	27.7							9
10	11.1	12.4	13.9	15.8	18.5	22.1	27.6						10
11	10.1	11.1	12.3	13.8	15.8	18.4	22.0	27.4					11
12	9.2	10.1	11.1	12.3	13.8	15.7	18.3	21.9	27.3				12
13	8.5	9.2	10.0	11.0	12.2	13.7	15.6	18.2	21.7	27.1			13
14	7.9	8.5	9.2	10.0	10.9	12.1	13.6	15.5	18.0	21.6	26.9		14
15	7.3	7.8	8.4	9.1	9.9	10.9	12.1	13.5	15.4	17.9	21.4	26.7	15
16	6.8	7.3	7.8	8.4	9.1	9.8	10.8	12.0	13.4	15.3	17.6	21.3	16
17	6.4	6.8	7.2	7.8	8.3	9.0	9.8	10.7	11.9	13.3	15.2	17.6	17
18	6.0	6.4	6.8	7.2	7.7	8.3	8.9	9.7	10.6	11.8	13.2	15.0	18
19	5.7	6.0	6.3	6.7	7.2	7.6	8.2	8.9	9.6	10.6	11.7	13.1	19
20	5.4	5.7	6.0	6.3	6.7	7.1	7.6	8.1	8.8	9.5	10.5	11.6	20
21	5.1	5.4	5.6	5.9	6.3	6.6	7.0	7.5	8.1	8.7	9.5	10.4	21
22	4.9	5.1	5.3	5.6	5.9	6.2	6.6	7.0	7.5	8.0	8.6	9.4	22
23	4.6	4.8	5.0	5.3	5.5	5.8	6.1	6.5	6.9	7.4	7.9	8.5	23
24	4.4	4.5	4.8	5.0	5.2	5.5	5.8	6.1	6.4	6.8	7.3	7.8	24
25	4.2	4.4	4.6	4.7	5.0	5.2	5.4	5.7	6.0	6.4	6.8	7.2	25
26	4.0	4.2	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.0	6.3	6.7	26
27	3.9	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.6	5.9	6.2	27
28	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	5.0	5.3	5.5	5.8	28
29	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	4.7	5.0	5.2	5.5	29
30	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	4.5	4.7	4.9	5.1	30
31	3.3	3.4	3.5	3.6	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	31
32	3.1	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	32
33	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	33
34	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.6	3.7	3.8	3.9	4.1	34
35	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	35
36	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	36
37	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	37
38	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.2	3.2	3.3	38
39	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	39
40	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.9	3.0	3.0	40
41	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	41
42	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	42
43	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.7	43
44	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	44
45	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.4	2.4	45
46	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	46
47	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	47
48	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	48
49	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	49
50	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	50
51	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	51
52	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	52
53	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	53
54	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	54
55													55
56	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	56
57	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	57
58	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	58
59	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	59
60	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	60
61	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	61
62													62
63													63
64													64
65													65
66													66
67													67
68													68
69													69
70													70
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	

TABLE XXXII.

Variation of the Sun's Altitude in one minute from noon.

Variation in the Sun's Altitude in One Minute from Noon.														
Lat.	Declination of the same name as the Latitude.													Lat.
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
0°	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0°
1	10.1	9.2	8.5	7.8	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.8	4.6	1
2	11.1	10.0	9.2	8.4	7.8	7.2	6.8	6.3	6.0	5.6	5.3	5.0	4.8	2
3	12.3	11.0	10.0	9.1	8.4	7.8	7.2	6.7	6.3	5.9	5.6	5.3	5.0	3
4	13.8	12.2	10.9	9.9	9.1	8.3	7.7	7.2	6.7	6.3	5.9	5.5	5.2	4
5	15.7	13.7	12.1	10.9	9.8	9.0	8.3	7.6	7.1	6.6	6.2	5.8	5.5	5
6	18.3	15.6	13.6	12.1	10.8	9.8	8.9	8.2	7.6	7.0	6.6	6.1	5.8	6
7	21.9	18.2	15.5	13.5	12.0	10.7	9.7	8.9	8.1	7.5	7.0	6.5	6.1	7
8	27.3	21.7	18.0	15.4	13.4	11.9	10.6	9.6	8.8	8.1	7.5	6.9	6.4	8
9		27.1	21.6	17.9	15.3	13.3	11.8	10.6	9.5	8.7	8.0	7.4	6.8	9
10			26.9	21.4	17.8	15.2	13.2	11.7	10.5	9.5	8.6	7.9	7.3	10
11				26.7	21.3	17.6	15.0	13.1	11.6	10.4	9.4	8.5	7.8	11
12					26.5	21.1	17.5	14.9	13.0	11.5	10.3	9.3	8.4	12
13						26.2	20.9	17.3	14.8	12.8	11.3	10.1	8.9	13
14							20.7	17.1	14.6	12.7	11.2	10.0	8.7	14
15							25.7	20.4	16.9	14.4	12.5	11.1	9.7	15
16	26.5							25.4	20.2	16.7	14.3	12.4	10.9	16
17	21.1	26.2							25.1	20.0	16.5	14.1	12.1	17
18	17.5	20.9	26.0							24.8	19.7	16.3	13.8	18
19	14.9	17.3	20.7	25.7							24.5	19.4	15.9	19
20	13.0	14.8	17.1	20.4	25.4							24.2	15.6	20
21	11.5	12.8	14.6	16.9	20.2	25.1							15.3	21
22	10.3	11.3	12.7	14.4	16.7	20.0	24.8						15.0	22
23	9.3	10.1	11.2	12.5	14.3	19.5	19.7	24.5					14.7	23
24	8.4	9.2	10.0	11.1	12.4	14.1	16.3	19.5	24.2				14.4	24
25	7.7	8.3	9.0	9.9	10.9	12.2	13.9	16.1	19.2	23.8			14.1	25
26	7.1	7.6	8.2	8.9	9.8	10.8	12.1	13.7	15.9	18.9	23.5		13.8	26
27	6.6	7.0	7.5	8.1	8.8	9.6	10.6	11.9	13.5	15.6	18.6		13.5	27
28	6.2	6.5	7.0	7.4	8.0	8.7	9.5	10.5	11.7	13.3	15.4	18.3	22.7	28
29	5.7	6.1	6.4	6.9	7.3	7.9	8.6	9.4	10.3	11.5	13.1	15.1	18.0	29
30	5.4	5.7	6.0	6.4	6.8	7.2	7.8	8.4	9.2	10.1	11.3	12.8	14.9	30
31	5.1	5.3	5.6	5.9	6.3	6.7	7.1	7.7	8.3	9.0	10.0	11.1	12.6	31
32	4.8	5.0	5.2	5.5	5.8	6.2	6.6	7.0	7.5	8.1	8.9	9.8	10.9	32
33	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.4	6.9	7.4	8.0	8.7	9.6	33
34	4.3	4.4	4.6	4.8	5.1	5.3	5.6	5.9	6.3	6.8	7.3	7.8	8.6	34
35	4.0	4.2	4.4	4.5	4.7	5.0	5.2	5.5	5.8	6.2	6.6	7.1	7.7	35
36	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.5	7.0	36
37	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.3	5.6	6.0	6.4	37
38	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.2	5.5	5.9	38
39	3.3	3.4	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.1	5.4	39
40	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	5.0	40
41	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.4	4.6	41
42	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.7	3.8	4.0	4.1	4.3	42
43	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.5	3.6	3.7	3.9	4.0	43
44	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	44
45	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	45
46	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	46
47	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.1	47
48	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	48
49	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	49
50	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	50
52	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.4	52
54	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	54
56	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	56
58	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	58
60	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.6	1.6	60
62	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.4	62
64	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	64
66	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	66
68	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	68
70	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	70
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	

TABLE XXXIII.

241

To reduce the numbers of Table XXII to other given intervals of time from noon.

Time from Noon													
h	m	p	2	3	4	5	6	7	8	9	10	11	12
0	0.0	1.0	4.0	9.0	16.0	25.0	36.0	49.0	64.0	81.0	100.0	121.0	144.0
1	0.0	1.0	4.1	9.1	16.1	25.2	36.2	49.2	64.3	81.3	100.3	121.4	144.4
2	0.0	1.1	4.1	9.2	16.2	25.3	36.4	49.3	64.5	81.5	100.5	121.6	144.6
3	0.0	1.1	4.2	9.3	16.3	25.5	36.5	49.5	64.6	81.6	100.6	121.7	144.7
4	0.0	1.1	4.3	9.4	16.4	25.7	36.6	49.6	64.7	81.7	100.7	121.8	144.8
5	0.0	1.2	4.3	9.5	16.5	25.8	36.7	49.7	64.8	81.8	100.8	121.9	144.9
6	0.0	1.2	4.4	9.6	16.6	26.0	36.8	49.8	64.9	81.9	100.9	122.0	145.0
7	0.0	1.2	4.5	9.7	16.7	26.2	36.9	49.9	65.0	82.0	101.0	122.1	145.1
8	0.0	1.3	4.5	9.8	16.8	26.4	37.0	50.0	65.1	82.1	101.1	122.2	145.2
9	0.0	1.3	4.6	9.9	16.9	26.5	37.1	50.1	65.2	82.2	101.2	122.3	145.3
10	0.0	1.4	4.7	10.0	17.0	26.7	37.2	50.2	65.3	82.3	101.3	122.4	145.4
11	0.0	1.4	4.8	10.1	17.1	26.9	37.3	50.3	65.4	82.4	101.4	122.5	145.5
12	0.0	1.4	4.8	10.2	17.2	27.0	37.4	50.4	65.5	82.5	101.5	122.6	145.6
13	0.0	1.5	4.9	10.3	17.3	27.2	37.5	50.5	65.6	82.6	101.6	122.7	145.7
14	0.1	1.5	5.0	10.4	17.4	27.4	37.6	50.6	65.7	82.7	101.7	122.8	145.8
15	0.1	1.6	5.1	10.5	17.5	27.6	37.7	50.7	65.8	82.8	101.8	122.9	145.9
16	0.1	1.6	5.1	10.6	17.6	27.7	37.8	50.8	65.9	82.9	101.9	123.0	146.0
17	0.1	1.6	5.2	10.7	17.7	27.9	37.9	50.9	66.0	83.0	102.0	123.1	146.1
18	0.1	1.7	5.2	10.8	17.8	28.0	38.0	51.0	66.1	83.1	102.1	123.2	146.2
19	0.1	1.7	5.3	10.9	17.9	28.2	38.1	51.1	66.2	83.2	102.2	123.3	146.3
20	0.1	1.7	5.3	11.0	18.0	28.3	38.2	51.2	66.3	83.3	102.3	123.4	146.4
21	0.1	1.8	5.4	11.1	18.1	28.4	38.3	51.3	66.4	83.4	102.4	123.5	146.5
22	0.1	1.8	5.4	11.2	18.2	28.6	38.4	51.4	66.5	83.5	102.5	123.6	146.6
23	0.1	1.9	5.5	11.3	18.3	28.7	38.5	51.5	66.6	83.6	102.6	123.7	146.7
24	0.1	1.9	5.5	11.4	18.4	28.9	38.6	51.6	66.7	83.7	102.7	123.8	146.8
25	0.2	2.0	5.6	11.5	18.5	29.0	38.7	51.7	66.8	83.8	102.8	123.9	146.9
26	0.2	2.0	5.7	11.6	18.6	29.2	38.8	51.8	66.9	83.9	102.9	124.0	147.0
27	0.2	2.1	5.7	11.7	18.7	29.3	38.9	51.9	67.0	84.0	103.0	124.1	147.1
28	0.2	2.1	5.8	11.8	18.8	29.5	39.0	52.0	67.1	84.1	103.1	124.2	147.2
29	0.2	2.2	5.8	11.9	18.9	29.7	39.1	52.1	67.2	84.2	103.2	124.3	147.3
30	0.2	2.2	5.9	12.0	19.0	29.8	39.2	52.2	67.3	84.3	103.3	124.4	147.4
31	0.3	2.3	5.9	12.1	19.1	30.0	39.3	52.3	67.4	84.4	103.4	124.5	147.5
32	0.3	2.3	6.0	12.2	19.2	30.1	39.4	52.4	67.5	84.5	103.5	124.6	147.6
33	0.3	2.4	6.0	12.3	19.3	30.3	39.5	52.5	67.6	84.6	103.6	124.7	147.7
34	0.3	2.4	6.1	12.4	19.4	30.5	39.6	52.6	67.7	84.7	103.7	124.8	147.8
35	0.3	2.5	6.1	12.5	19.5	30.7	39.7	52.7	67.8	84.8	103.8	124.9	147.9
36	0.4	2.6	6.2	12.6	19.6	30.9	39.8	52.8	67.9	84.9	103.9	125.0	148.0
37	0.4	2.6	6.2	12.7	19.7	31.0	39.9	52.9	68.0	85.0	104.0	125.1	148.1
38	0.4	2.7	6.3	12.8	19.8	31.2	40.0	53.0	68.1	85.1	104.1	125.2	148.2
39	0.4	2.7	6.3	12.9	19.9	31.4	40.1	53.1	68.2	85.2	104.2	125.3	148.3
40	0.4	2.8	6.4	13.0	20.0	31.6	40.2	53.2	68.3	85.3	104.3	125.4	148.4
41	0.5	2.8	6.4	13.1	20.1	31.8	40.3	53.3	68.4	85.4	104.4	125.5	148.5
42	0.5	2.9	6.5	13.2	20.2	32.0	40.4	53.4	68.5	85.5	104.5	125.6	148.6
43	0.5	2.9	6.5	13.3	20.3	32.2	40.5	53.5	68.6	85.6	104.6	125.7	148.7
44	0.5	3.0	6.6	13.4	20.4	32.4	40.6	53.6	68.7	85.7	104.7	125.8	148.8
45	0.6	3.1	6.6	13.5	20.5	32.6	40.7	53.7	68.8	85.8	104.8	125.9	148.9
46	0.6	3.1	6.7	13.6	20.6	32.8	40.8	53.8	68.9	85.9	104.9	126.0	149.0
47	0.6	3.2	6.7	13.7	20.7	33.0	40.9	53.9	69.0	86.0	105.0	126.1	149.1
48	0.6	3.2	6.8	13.8	20.8	33.2	41.0	54.0	69.1	86.1	105.1	126.2	149.2
49	0.7	3.3	6.8	13.9	20.9	33.4	41.1	54.1	69.2	86.2	105.2	126.3	149.3
50	0.7	3.4	6.9	14.0	21.0	33.6	41.2	54.2	69.3	86.3	105.3	126.4	149.4
51	0.7	3.4	6.9	14.1	21.1	33.8	41.3	54.3	69.4	86.4	105.4	126.5	149.5
52	0.8	3.5	7.0	14.2	21.2	34.0	41.4	54.4	69.5	86.5	105.5	126.6	149.6
53	0.8	3.5	7.0	14.3	21.3	34.2	41.5	54.5	69.6	86.6	105.6	126.7	149.7
54	0.8	3.6	7.1	14.4	21.4	34.4	41.6	54.6	69.7	86.7	105.7	126.8	149.8
55	0.8	3.6	7.1	14.5	21.5	34.6	41.7	54.7	69.8	86.8	105.8	126.9	149.9
56	0.9	3.7	7.2	14.6	21.6	34.8	41.8	54.8	69.9	86.9	105.9	127.0	150.0
57	0.9	3.7	7.2	14.7	21.7	35.0	41.9	54.9	70.0	87.0	106.0	127.1	150.1
58	0.9	3.8	7.3	14.8	21.8	35.2	42.0	55.0	70.1	87.1	106.1	127.2	150.2
59	0.9	3.8	7.3	14.9	21.9	35.4	42.1	55.1	70.2	87.2	106.2	127.3	150.3
60	1.0	3.9	7.4	15.0	22.0	35.6	42.2	55.2	70.3	87.3	106.3	127.4	150.4

TABLE XXXIV.
Errors arising from a deviation of 1' in the parallelism of the surfaces of the central mirror.

Obs'd Angle.	Obs. to right	Obs. to left	Obs. cross.	Fifth col.
D	"	"	"	"
0	0	0	0	0
10	2	1	2	0
20	6	2	4	2
30	10	1	6	4
40	16	0	8	7
45	19	1	9	9
50	23	2	11	11
55	28	4	12	14
60	33	5	14	17
65	39	7	16	21
70	46	10	18	25
75	54	12	21	30
80	1 4	16	24	35
85	1.15	19	28	41
90	1.27	23	32	48
95	1.43	28	37	56
100	2 1	33	44	1 6
105	2.23	39	52	1.16
110	2.49	46	1 1	1.29
115	3.23	54	1.14	1.44
120	4.05	1 4	1.30	2 3
130				2.51
140				4 6

TABLE XXXV.
Angle of deviation.

Angles Obs'd	10'	15'	20'	25'	30'	35'	40'	45'	50'	55'
D	"	"	"	"	"	"	"	"	"	"
0	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	2	2	3	4	5
20	0	1	1	2	3	4	5	6	8	9
30	0	1	2	3	4	6	7	9	12	14
40	1	1	3	4	6	8	10	13	16	19
50	1	2	3	5	7	10	13	16	20	25
60	1	2	4	6	9	12	16	20	25	30
65	1	3	4	7	10	14	18	23	28	34
70	1	3	5	8	11	15	20	25	31	37
75	1	3	5	8	12	16	21	27	33	41
80	1	3	6	9	13	18	23	30	37	46
85	2	4	6	10	14	20	26	32	40	48
90	2	4	7	11	16	21	28	35	44	53
95	2	4	8	12	17	23	30	39	48	58
100	2	5	8	13	19	25	33	42	52	63
105	2	5	9	14	20	28	36	46	57	69
110	2	6	10	16	22	31	40	50	62	75
115	3	6	11	17	25	34	44	55	68	83
120	3	7	12	19	27	37	48	61	76	91

TABLE XXXVI.
Corrections of the mean Refraction for various heights of the Thermometer and Barometer.

Ht. Tl.	30°	31°	32°	33°	34°	35°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	60°	64°	68°	72°	76°
Barom.	30.00	31.84	31.82	30.94	30.67	30.36	30.05	29.75	29.45	29.16	28.88	28.60	28.33	28.06								
app. alt.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	2 41	2 13	1 55	1 33	1 12	51	30	10	10	29	48	1 71	35	1 43	1 1						
0 30		2 18	1 58	1 39	1 20	1 2	44	26	9	8	25	41	58	1 13	29	1 44						
1 0		1 59	1 42	1 26	1 9	53	38	22	7	7	22	36	50	1 31	17	1 30						
1 30		1 43	1 29	1 14	1 0	46	33	19	6	6	19	31	43	55	1 6	1 18						
2 0		1 30	1 18	1 5	56	38	40	29	6	6	16	27	37	48	58	1 2						
2 30		1 20	1 8	57	16	36	25	15	5	5	15	24	33	43	51	1 0						
3 0		1 11	1 1	51	41	32	22	13	4	4	13	21	30	38	46	53						
4		58	49	41	33	26	18	11	4	4	10	17	24	31	37	43						
5		48	41	35	28	22	15	9	3	3	9	14	20	26	31	36						
6		41	35	30	24	18	13	8	3	3	7	12	17	22	26	31						
7		36	31	26	21	16	11	7	2	2	7	11	15	19	23	27						
8		32	27	23	18	14	10	6	2	2	6	10	13	17	20	24						
9		28	24	20	16	13	9	5	2	2	5	9	12	15	18	21						
10		25	22	18	15	11	8	5	2	2	5	8	10	14	16	19						
12		21	18	15	12	10	7	4	1	1	4	6	9	11	14	16						
14		18	16	13	11	8	6	3	1	1	3	6	8	10	12	14						
16		16	14	11	9	7	5	3	1	1	3	5	7	9	10	12						
18		14	12	10	8	6	4	3	1	1	3	4	6	7	9	11						
21		12	10	9	7	5	4	2	1	1	2	4	5	6	8	10						
24		10	9	7	6	5	3	2	1	1	2	3	4	5	7	9						
27		9	8	6	5	4	3	2	1	1	2	3	4	5	6	8						
30		8	7	6	5	4	3	2	1	0	1	2	3	4	5	7						
35		7	6	5	4	3	2	1	0	0	1	2	3	4	5	6						
40		6	5	4	3	2	2	1	0	0	1	2	3	4	5	6						
45		5	4	3	3	2	1	1	0	0	1	1	2	3	4	5						
50		4	3	3	2	2	1	1	0	0	1	1	2	3	4	5						
55		3	2	2	2	1	1	1	0	0	0	1	1	2	3	4						
70		2	1	1	1	1	1	0	0	0	0	0	1	1	1	2						
80		1	1	1	0	0	0	0	0	0	0	0	0	0	0	1						
90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						

TABLE XXXVII.
Longitudes and Latitudes of Stars, for Jan. 1, 1820.

Names of Stars.	Mag.	Longitude.	Ann. Var. alt. 1820.	Latitude.	Ann. var. alt. 1820.
Pegasi..... <i>Algenib</i>	2	0. 6.38.49	50.09	12.35.42 N.	+0.12
Andromedæ..... <i>Alpheratz</i>	2	0.11.48. 6	49.94	25.41. 7 N.	+0.16
Piscium.....	4.3	0.21.18.10	50.16	5.22. 2 N.	+0.25
Arietis.....	2.3	1. 5. 8.44	5.27	9.57.38 N.	+0.16
Ceti..... <i>Menkar</i>	2	1.11.48.18	50.27	12.35.44 S.	-0.37
Pléiadam..... <i>Mayone</i>	3	1.27.28.35	50.19	4. 2. 3 N.	+0.43
Tauri.....	3	2. 3.16.52	50.21	5.45. 1 N.	-0.45
Tauri.....	3.4	2. 5.56.33	50.20	2.33. 6 S.	-0.46
Tauri..... ALDEBARAN.....	1	2. 7.16.23	50.21	5.28.44 N.	-0.33
Orionis..... <i>Rigel</i>	1	2.14.18.41	50.24	31. 8.44 N.	-0.47
Aurigæ..... <i>Capella</i>	1	2.19.20. 0	50.19	22.52.12 N.	+0.48
Orionis.....	2	2.19.30.53	50.20	25.34.34 S.	-0.48
Tauri.....	2	2.20. 3.36	50.20	3.52.26 N.	+0.48
Orionis.....	2	2.20.57. 1	50.20	24.31.43 S.	-0.46
Orionis.....	2	2.22.10. 4	50.20	25.18.56 S.	-0.48
Tauri.....	3	2.22.16.10	50.20	2.13. 0 S.	-0.48
Orionis..... <i>Betelgeuse</i>	1	2.23.14.20	50.19	16. 3. 4 S.	-0.48
Geminorum.....	3.4	3. 0.53.52	50.20	0.51.31 S.	-0.48
Geminorum.....	3	3. 2.16.52	50.20	0. 0. 4 N.	-0.17
Geminorum.....	2.3	3. 6.3. 13	50.15	6.45.11 N.	-0.47
Geminorum.....	3	3. 7.25.24	50.20	2. 2.50 N.	+0.46
Canis Majoris Sirius.....	1	3.11.26.34	50.07	39.22.31 N.	-0.45
Geminorum.....	3.1	3.12.24.30	50.19	2. 3.36 S.	-0.45
Geminorum.....	3	3.16. 0.21	50.20	0.11.54 S.	-0.44
Geminorum..... <i>Castor</i>	1.2	3.17.11. 2	50.23	10. 5. 0 N.	+0.43
Geminorum..... <i>Pollux</i>	2	3.20.43.51	49.50	6.40.17 N.	+0.26
Canis Minoris Procyon.....	1.2	3.25.18.48	50.12	15.57.47 S.	-0.41
2 Cancri..... <i>Achubim</i>	1.3	3.11. 7.30	50.16	5. 5.39 N.	-0.31
Hydræ..... <i>Alphard</i>	2	3.24.16.30	50.02	22.23.38 S.	-0.29
Leonis.....	3.4	4.25.23.18	50.23	4.51.19 N.	+0.22
Leonis..... <i>Regulus</i>	1	4.27.19.31	49.94	0.27.39 N.	+0.22
Leonis..... <i>Denebola</i>	1.2	5.19. 7.31	50.30	12.17.10 N.	+0.03
Virginis.....	3	5.24.35.54	50.20	0.41.32 N.	-0.02
Virginis.....	4.3	6. 2.19.20	50.21	1.22.23 N.	-0.18
Virginis.....	3	6. 7.39.42	50.00	2.48.43 N.	-0.13
Virginis..... <i>Spica</i>	1	6.21.19.44	50.08	2. 2.20 S.	+0.17
Boulis..... <i>Arcturus</i>	1	6.21.43.30	50.45	30.54. 0 N.	-0.24
Coronæ Bor..... <i>Alphacca</i>	2.3	7. 4.45. 7	50.51	44.20.46 N.	-0.35
2 Lioræ..... <i>Zubenelch</i>	2.3	7.12.34.26	50.20	0.21.29 N.	-0.37
Serpentis.....	2.3	7.19.32.45	50.32	25.31.31 N.	-0.40
Libræ.....	3.4	7.22.37. 5	50.22	4.24.24 N.	-0.42
Scorpii.....	2.3	7.24.36.32	50.18	5.27.45 S.	+0.41
Scorpii.....	3.2	8. 0. 3.22	50.19	1.57.38 S.	+0.44
Scorpii.....	3	8. 0.25.27	50.19	5.26.59 S.	+0.45
Scorpii.....	2	8. 0.10.27	50.20	1. 1.57 N.	-0.45
Scorpii..... ANTARES.....	1	8. 7.14.54	50.12	4.32.41 S.	+0.42
Ophiuchi.....	3	8.18.52.48	50.20	1.19. 1 S.	+0.48
Ophiuchi..... <i>Ras Alhague</i>	2	8.19.57.23	50.21	35.52.26 N.	-0.18
Sagittarii.....	3	9. 9.52. 9	50.21	3.25.18 S.	+0.46
Lyre..... <i>Vega</i>	1	9.12.47.19	49.89	61.44.26 N.	-0.45
Sagittarii.....	3.4	9.13.44.18	50.19	1.27.16 N.	-0.45
Aquilæ.....	3	9.29.25.49	50.07	31.15.43 N.	-0.39
Aquilæ..... ATAIR.....	1.2	9.29.14.10	50.79	29.18.45 N.	+0.09
Aquilæ.....	3	9.29.55.13	50.05	26.42.32 N.	-0.38
2 Capricorni.....	3	10. 1.20.30	50.13	6.56.59 N.	-0.37
Capricorni.....	3	10. 1.31.52	50.17	4.36.32 N.	-0.37
Capricorni.....	4.3	10.19.16. 3	50.21	2.32.15 N.	+0.26
Capricorni.....	3	10.21. 1. 7	50.21	2.33.19 S.	+0.25
Aquarii.....	3	11. 0.50.36	50.11	10.40.16 N.	-0.19
Piscæ Aust..... FOMALHAUT.....	1	11. 1.19.32	50.59	21. 6.40 S.	+0.21
Cygni..... <i>Deneb</i>	1.2	11. 2.51.16	49.42	59.54.57 N.	-0.16
Pegasi..... <i>MARAB</i>	2	11.20.53.44	50.11	19.24.44 N.	+0.10

TABLE XXXVIII.
Reduct. of lat. and Hor. Par.
for Ellipticity.

Lat.	Reduct. of Lat.	Hor. Par.	Reduct. of Lat.	Hor. Par.
	0°	57'	51"	
0	0.000	0.0	0.0	0.0
2	0.479	0.0	0.0	0.0
4	1.369	0.1	0.1	0.1
6	2.227	0.1	0.1	0.1
8	3.052	0.2	0.2	0.2
10	3.848	0.3	0.3	0.4
12	4.613	0.4	0.4	0.5
14	5.354	0.6	0.7	0.7
16	6.069	0.8	0.9	0.9
18	6.757	1.0	1.1	1.1
20	7.418	1.2	1.3	1.4
22	8.062	1.5	1.6	1.7
24	8.687	1.8	1.9	2.0
26	9.294	2.0	2.2	2.3
28	9.883	2.3	2.5	2.7
30	10.454	2.7	2.9	3.1
32	11.007	3.0	3.2	3.4
34	11.543	3.3	3.6	3.8
36	12.062	3.7	3.9	4.2
38	12.565	4.0	4.3	4.6
40	13.052	4.4	4.7	5.0
42	13.524	4.7	5.1	5.5
44	13.981	5.1	5.5	5.9
46	14.424	5.5	5.9	6.3
48	14.853	5.9	6.3	6.7
50	15.268	6.2	6.7	7.2
52	15.670	6.6	7.1	7.6
54	16.059	6.9	7.5	8.0
56	16.436	7.3	7.8	8.4
58	16.801	7.6	8.2	8.8
60	17.154	7.9	8.5	9.1
62	17.496	8.3	8.9	9.5
64	17.827	8.6	9.2	9.9
66	18.148	8.8	9.5	10.2
68	18.459	9.1	9.8	10.5
70	18.760	9.4	10.1	10.8
72	19.052	9.6	10.3	11.0
74	19.335	9.8	10.5	11.3
76	19.609	10.0	10.7	11.5
78	19.874	10.1	10.9	11.7
80	20.130	10.3	11.1	11.8
82	20.377	10.4	11.2	12.0
84	20.615	10.5	11.3	12.1
86	20.844	10.5	11.3	12.1
88	21.064	10.6	11.4	12.2
90	21.275	10.6	11.4	12.2

TABLE XXXIX.
Aberration of Planets in Longitude.

Elong.	Uran.	Sat.	Jup.	Mars	Venus		Mercury	
					Elong.	Ab.	Elong.	Ab.
Con. 0	25"	27"	29"	36"	S.C. 0	43"	S.C. 0	46"
15	24	26	28	35	15	41	5	46
30	22	24	26	33	30	34	10	44
45	19	21	23	28	45	19	16	41
60	15	16	19	23	Gt.El. 14	20	37	34
75	10	12	14	18	45	9	25	29
90	5	6	9	12	30	0	Gt.El. 18	10
105	1	1	3	7	15	3	20	1
120	5	4	1	3	Inf.C. 3½	16	2	4
135	10	8	5	+	10	5	5	8
150	13	11	9	2	5	6	11	12
165	15	13	11	3	Inf.C. 5	10	10	14
Op. 180	15	13	11	4				

The aberration of the Sun in longitude is always 20".
The apparent place is given in the Nautical Almanac, and
by adding 20" the Sun's true longitude will be obtained.

TABLE XL.
Equat. Equinoxes in
Longitude.

D	Long. of Node		
	0	1	2
	+	+	+
	6	7	8
0	0.0	8.9	15.5
2	0.6	9.5	15.8
4	1.2	10.0	16.1
6	1.9	10.5	16.4
8	2.5	11.0	16.6
10	3.1	11.5	16.8
12	3.7	12.0	17.0
14	4.3	12.4	17.2
16	4.9	12.9	17.4
18	5.5	13.3	17.5
20	6.1	13.7	17.6
22	6.7	14.1	17.7
24	7.3	14.5	17.8
26	7.8	14.8	17.9
28	8.4	15.2	17.9
30	8.9	15.5	17.9
	5	4	3
	+	+	+
	11	10	9

TABLE XLI.
Aberration in Longitude.

D	Arg. Lat. = Arg. Long. - 3.45		
	0	1	2
	+	+	+
	6	7	8
0	20.0	17.3	15.0
2	20.0	17.0	14.8
4	20.0	16.6	14.5
6	19.9	16.2	14.1
8	19.8	15.8	13.7
10	19.7	15.3	13.2
12	19.6	14.9	12.8
14	19.4	14.4	12.3
16	19.2	13.9	11.8
18	19.0	13.4	11.3
20	18.8	12.9	10.8
22	18.5	12.3	10.2
24	18.3	11.8	9.7
26	18.0	11.2	9.1
28	17.7	10.6	8.5
30	17.3	10.0	7.9
	+	+	+
	6	4	3
	+	+	+
	11	10	9

Table XL contains the equation of the equinoxes in longitude to be applied with its sign to the mean longitudes of all the heavenly bodies. Thus on July 16, 1820, when the longitude of the moon's ascending node was 11s. 26° 0', the equation of the equinoxes was + 1". 2.

The correction in Table XLI corresponding to the Argument of Longitude being found, on the logarithm added to the log. secant (less radius) of the star's latitude will be the log. of the star's aberration in longitude, to be applied with its sign to the mean longitude. The logarithm of the correction in Table XL corresponding to the Argument of Latitude added to the log. sine, of the star's latitude will be the aberration of the star in latitude, to be applied with its sign to the mean lat.

Example. Required the Aberration of α Pegasi, July 16, 1820?

☉ long. 3s. 23° 46'

* long. 11s. 20. 59

Arg. long. 4s. 2. 47 Tab. 41 + 10". 8 log. 1.03342 Arg. lat. 1s. 2° 47' Tab. 41 - 16". 9 log. 1.27180

* Latitude 19° 23'

Sec. 0.02543

Sine 9.28171

* Aberr. long. + 11". 5

Log. 1.05885

* Aberr. Lat. - 5". 6

Log. 0.74950

TABLE XLII.

245

Aberration in Right Ascension and Declination.

PART I.						PART II.						PART III.									
*RA — \odot Long.						Ar RA — *RA + \odot Lon						Ar 3d Dec — \odot Lon + *Dec						Ar 3d Dec — \odot Lon — *Dec	Addn if Dec is 18.		
— Arg R. A. + 3 signs						Ar Dec — Arg R. A. + 3 signs						Ar 3d Dec — \odot Lon — *Dec									
6	1	7	2	8		D	0	6	1	7	2	8		D	0	6	1	7	2	8	
+	—	+	—	+		+	+	—	+	—	+	—		+	—	+	—	+	—	+	
17	16	60	9	53	30	0	0	83	0	77	0	41	30	0	3	98	3	45	1	99	30
17	16	43	9	30	29	1	0	83	0	71	0	40	29	1	3	98	3	41	1	93	29
16	16	26	9	00	28	2	0	83	0	70	0	39	28	2	3	98	3	38	1	87	28
15	16	08	8	70	27	3	0	83	0	68	0	38	27	3	3	98	3	34	1	81	27
13	16	90	8	40	26	4	0	82	0	66	0	36	26	4	3	97	3	30	1	75	26
10	16	71	8	10	25	5	0	82	0	68	0	35	25	5	3	97	3	26	1	68	25
07	16	51	7	80	24	6	0	82	0	67	0	34	24	6	3	96	3	22	1	62	24
03	16	31	7	49	23	7	0	82	0	66	0	32	23	7	3	95	3	18	1	56	23
99	16	11	7	18	22	8	0	82	0	65	0	31	22	8	3	94	3	14	1	49	22
94	14	90	6	87	21	9	0	82	0	64	0	30	21	9	3	93	3	09	1	43	21
88	14	69	6	56	20	10	0	81	0	63	0	28	20	10	3	92	3	05	1	36	20
82	14	47	6	24	19	11	0	81	0	62	0	27	19	11	3	91	3	00	1	30	19
75	14	25	5	92	18	12	0	81	0	61	0	26	18	12	3	89	3	96	1	23	18
68	14	02	5	61	17	13	0	81	0	60	0	24	17	13	3	88	3	91	1	16	17
60	13	79	5	28	16	14	0	80	0	59	0	23	16	14	3	86	3	86	1	10	16
52	13	56	4	96	15	15	0	80	0	58	0	21	15	15	3	85	3	82	1	03	15
43	13	32	4	64	14	16	0	79	0	57	0	20	14	16	3	83	3	77	0	96	14
34	13	08	4	31	13	17	0	79	0	56	0	19	13	17	3	81	3	72	0	90	13
23	12	83	3	99	12	18	0	79	0	55	0	17	12	18	3	79	3	66	0	83	12
13	12	58	3	66	11	19	0	78	0	54	0	16	11	19	3	76	3	61	0	76	11
02	12	32	3	33	10	20	0	78	0	53	0	14	10	20	3	74	3	56	0	69	10
90	12	07	3	00	9	21	0	77	0	52	0	13	9	21	3	72	3	51	0	62	9
78	11	80	2	67	8	22	0	77	0	51	0	12	8	22	3	69	3	46	0	55	8
65	11	54	2	34	7	23	0	76	0	50	0	10	7	23	3	66	3	40	0	49	7
52	11	27	2	00	6	24	0	76	0	49	0	9	6	24	3	64	3	34	0	42	6
38	11	00	1	67	5	25	0	75	0	47	0	7	5	25	3	61	3	28	0	35	5
23	10	72	1	34	4	26	0	74	0	46	0	6	4	26	3	58	3	23	0	28	4
08	10	41	1	00	3	27	0	74	0	45	0	4	3	27	3	55	3	17	0	21	3
93	10	16	0	67	2	28	0	73	0	44	0	3	2	28	3	52	3	11	0	14	2
77	9	87	0	33	1	29	0	72	0	43	0	1	1	29	3	48	3	05	0	07	1
60	9	59	0	00	0	30	0	72	0	41	0	0	0	30	3	45	3	99	0	00	0
+	—	+	—	+		D		+	—	+	—	+		D		—	+	—	—	+	D
6	10	4	9	3				1	5	10	4	9	3			11	5	10	4	9	3

For the Aberration of a Star in Right Ascension.—Find the Equations in Part I and II according to the arguments of R. A. at the top of those tables, and connect them according to their signs, and to the log of this sum or difference add the log secant (less or more) of the star's declination, the sum will be the log of the aberration in Right Ascension of a degree, which divided by 15 will be reduced to time, to be applied to the R. A.

For the Aberration of a Star in Declination.—Increase the former arguments of R. A. 90°, and connect together the corresponding equations of Part I and II to the log of \sin , and the log \cos of the star's declination, the sum will be the log of arch 1st. With arguments at the top of Part III find in that Table arches 2d and 3d. These three arches added with their signs will be the aberration in declination, to be applied to the mean declination.

EXAMPLE. Required the Aberration in R. A. and Dec. of α Pegasi, July 16, 1820?
 *R. A. — 22h 55' 48" = 11.13° 37' *Dec 15° 14' N. and by N. A. \odot Long 34° 23' 46"
 11.13° 37'
 3.23 46

2.20 11 Part I. +12.27	Diff. + 3. = 10.20 11	Part I. — 14.73
3.7 43 Part II. — 0.11	Sum + 3. = 6.7 43	Part II. — 0.82
*Dec. 14° 14'	+12.16 log 1.03493	— 15.55 log 1.19173
	sec 0.01354	Sine 9.39071
R. A. + 12.5	log 1.02847	Arch 1st — 3'.82
		log 0.58244
R. A. in time 0°.23	\odot Long + *Dec 4.80. 0' Arch 2d + 2.45	{ If Decl. n S. add 6. to the Argum. Part. III.
	\odot Long — *Dec 3.9. 32 Arch 3d + 0.66	
* Aberr. in Declination — 0.71		

Nutation in Right Ascension and Declination to be applied to the mean values.

PART I. Arg. R. A. = * R. A. — Lon. γ node + 6 signs if Dec. is S. Arg. Dec. = Arg. R. A. + 3 signs.							PART II. Arg. R. A. = * R. A. + lon. γ node + 6 signs if Dec. is S. Arg. Dec. = Arg. R. A. + 3 signs.							PART III. Equation Equinox to R. A. Arg. = Long. γ node.						
D	0.	6.	1.	7.	2.	8.	D	0.	6.	1.	7.	2.	8.	D	0.	6.	1.	7.	2.	8.
0	8'	33	7	21	4	16	0	1'	22	1	06	0	61	0	0	0	8	2	11	2
1	8	33	7	14	4	04	1	1	22	1	05	0	59	1	0	3	8	4	14	3
2	8	32	7	06	3	91	2	1	22	1	05	0	57	2	0	6	8	7	14	3
3	8	32	6	59	3	78	3	1	22	1	05	0	55	3	0	9	8	9	14	3
4	8	31	6	51	3	65	4	1	22	1	04	0	53	4	1	1	9	2	14	3
5	8	30	6	42	3	52	5	1	22	1	04	0	52	5	1	4	9	4	14	3
6	8	28	6	34	3	39	6	1	21	0	99	0	50	6	1	7	9	6	13	3
7	8	27	6	25	3	25	7	1	21	0	97	0	48	7	2	0	9	9	13	3
8	8	25	6	16	3	12	8	1	21	0	96	0	46	8	2	3	10	1	13	3
9	8	23	6	07	2	99	9	1	20	0	95	0	44	9	2	6	10	3	13	3
10	8	20	6	00	2	85	10	1	20	0	95	0	42	10	2	9	10	5	13	3
11	8	18	6	00	2	71	11	1	20	0	92	0	40	11	3	1	10	7	13	3
12	8	15	6	19	2	57	12	1	19	0	91	0	38	12	3	4	11	0	13	3
13	8	12	6	09	2	44	13	1	19	0	89	0	36	13	3	7	11	2	13	3
14	8	08	5	59	2	30	14	1	18	0	88	0	34	14	4	0	11	4	13	3
15	8	05	5	49	2	16	15	1	18	0	86	0	32	15	4	2	11	6	13	3
16	8	01	5	39	2	02	16	1	17	0	85	0	30	16	4	5	11	8	13	3
17	7	57	5	28	1	87	17	1	17	0	83	0	27	17	4	8	12	10	13	3
18	7	52	5	17	1	73	18	1	16	0	82	0	25	18	5	1	12	12	13	3
19	7	48	5	06	1	59	19	1	15	0	80	0	23	19	5	3	12	14	13	3
20	7	43	5	00	1	45	20	1	15	0	78	0	21	20	5	6	12	16	13	3
21	7	38	5	00	1	30	21	1	14	0	77	0	19	21	5	9	12	18	13	3
22	7	32	5	13	1	16	22	1	13	0	75	0	17	22	6	1	12	20	13	3
23	7	27	5	01	1	02	23	1	12	0	73	0	15	23	6	4	13	22	13	3
24	7	21	4	50	0	87	24	1	11	0	72	0	13	24	6	7	13	24	13	3
25	7	15	4	40	0	73	25	1	11	0	70	0	11	25	6	9	13	26	13	3
26	7	09	4	30	0	58	26	1	10	0	68	0	09	26	7	2	13	28	13	3
27	7	03	4	20	0	44	27	1	09	0	66	0	06	27	7	4	13	30	13	3
28	7	00	4	10	0	29	28	1	08	0	65	0	04	28	7	7	13	32	13	3
29	7	00	4	00	0	15	29	1	07	0	63	0	02	29	7	9	14	34	13	3
30	7	00	4	00	0	00	30	1	06	0	61	0	00	30	8	2	14	36	13	3
	—	+	—	+	—	+		—	+	—	+	—	+		+	—	+	—	+	—
	11.	5.	10.	4.	9.	3.		11.	5.	10.	4.	9.	3.		11.	5.	10.	4.	9.	3.

To find the Nutation of a Star in Right Ascension.—Find in Parts I. II. the Equations corresponding to the arguments of R. A. at the top of the tables, connect them according to the signs, and to the log. of the sum or difference add the log. tangent of the star's declination, the sum will be the log. of an arch, to which apply the equation of the equinoxes, Part III. corresponding to the long. of the γ node (page 3, N. A.) the sum or difference will be the Nutation in Right Ascension in seconds of a degree, which divided by 15 will be reduced to seconds of time.

To find the Nutation of a Star in Declination.—Increase the arguments of R. A. Part I. II. by 3 signs, and connect the corresponding equations of those tables, which will be the nutation of declination. Note. In putting the R. A. of the star equal to 3 signs, the nutation in declination will be the equation of the obliquity of the ecliptic.

EXAMPLE. Required the Nutation of a Pegasi, in R. A. and Decl. July 16, 1820?

* R. A. Tab. 8 11s. 13.57'

γ Node N. A. 11. 26. 0

Diff. 11. 17.57 Part I. — 3.15

Sum 11. 9.57 Part II. — 1. 15

— 9. $\log 0.06848$

* Declination $14^{\circ} 14'$ tang. 9.40425

Arch — $2^{\circ} 4'$ log 0.37273

Part III Eq. Arg. 11s. 26. 0 + 1

Nutation in Right Ascension — 1. 35 — 0.10 s.

If the Declination of the Star was south, the arguments Part I. II. of Right Ascension and Declination must be increased 6 signs.

Diff. + 3s = 2s. 17.57' Part I. — 1.174

Sum + 3s = 2s. 9.57 Part II. — 42

Nut. in Dec. — 2.16

6s. — γ Node = 6s. 4d. Part I. + 8.31

6s. + γ Node = 5s. 26d. Part II. + 1.22

Equat. Obliq. Eclipt. + 2.53

TABLE XLIV.

To find the Augmentation of the Moon's Semidiameter, by the altitude of the Nonage-simal and the apparent distance of the Moon therefrom.

[illegible]

Arg. Sum of Prob. Eq.	PART IV. Arg. ☿'s Horiz. Semi. Diam.															Find in P. I. the two equinoxes corres- ponding to the argu- ments at the top and connect them accord- ing to their signs. With this sum or dif- ference take out the corresponding correc- tion P. II. In oscula- tions the correction P. III. is to be found with the ☿'s Par. lat. at the top and her true lat. at the side, but in solar Eclipses this p. is no- thing. Connect these three parts and with the sum enter the side column of P. IV. and find the ☿'s Horiz. Semi. Dia. at the top, the corresponding cor-
	14'					15'					16'					
	40"	50"	0'	10"	20"	30"	40"	50"	0'	10"	20"	30"	40"	50"		
"	"	"	"	"	"	"	"	"	"	"	"	"	"	"		
1	0.16	0.14	0.12	0.10	0.08	0.06	0.04	0.02	0.00	0.02	0.04	0.06	0.09	0.11		
2	0.32	0.28	0.24	0.20	0.16	0.12	0.08	0.04	0.00	0.04	0.08	0.13	0.17	0.21		
3	0.48	0.42	0.36	0.30	0.24	0.18	0.12	0.06	0.00	0.06	0.13	0.19	0.26	0.32		
4	0.64	0.56	0.48	0.41	0.33	0.25	0.16	0.08	0.00	0.08	0.17	0.25	0.34	0.43		
5	0.80	0.70	0.61	0.51	0.41	0.31	0.21	0.10	0.00	0.10	0.21	0.32	0.43	0.53		
6	0.96	0.84	0.73	0.61	0.49	0.37	0.25	0.12	0.00	0.13	0.25	0.38	0.51	0.64		
7	1.12	0.98	0.85	0.71	0.57	0.43	0.29	0.15	0.00	0.15	0.29	0.44	0.60	0.75		
8	1.28	1.12	0.97	0.81	0.65	0.49	0.33	0.17	0.00	0.17	0.34	0.51	0.68	0.86		
9	1.44	1.26	1.09	0.91	0.73	0.55	0.37	0.19	0.00	0.19	0.38	0.57	0.77	0.96		
10	1.60	1.41	1.21	1.01	0.82	0.62	0.41	0.21	0.00	0.21	0.42	0.63	0.85	1.07		
11	1.76	1.55	1.33	1.12	0.90	0.68	0.45	0.23	0.00	0.23	0.46	0.70	0.94	1.18		
12	1.92	1.69	1.45	1.22	0.98	0.74	0.49	0.25	0.00	0.25	0.51	0.76	1.02	1.28		
13	2.08	1.83	1.57	1.32	1.06	0.80	0.54	0.27	0.00	0.27	0.56	0.83	1.11	1.39		
14	2.24	1.97	1.70	1.42	1.14	0.86	0.58	0.29	0.00	0.29	0.59	0.89	1.19	1.50		
15	2.40	2.11	1.82	1.52	1.22	0.92	0.62	0.31	0.00	0.31	0.63	0.95	1.28	1.60		
16	2.56	2.25	1.94	1.62	1.31	0.98	0.66	0.33	0.00	0.34	0.67	1.02	1.36	1.71		

applied, with its sign to the sum of the three first parts will give the Aug. of the ☿'s S. D.
 Thus in Ex. I Prob. 5. Appendix. The Alt. Nonag. is $24^{\circ} 59'$ Dis. Nonag. $(D + P) 20^{\circ}$
 16". ☿'s S. D. by N. A. $16' 27''$. Hence Arg. P. I. are $24^{\circ} 56' \pm 20^{\circ} 46'$ that is $24^{\circ} 20' 45''$
 and $24^{\circ} 15'$ 15" to which correspond $+ 8' 12'' + 6' 01'' = + 14' 19''$. This gives in P. II. $+ 0'$
 21 P. III is $0'$. The sum of the three parts is $+ 14'$. 4. with which and the ☿'s S. D. $16' 27''$ 7.
 P. IV. is nearly $+ 0'$ 8. this connected with $14'$. 4 gives the Aug. of ☿'s S. D. $15' 2''$ as in Prob.
 VI. Appendix.

Equation of Second Differences to be applied to the mean longitude or latitude with the sign contrary to that of the mean time second differences.

Ap. time after noon or midnight		Second Difference											
		1	2	3	4	5	6	7	8	9	10	11	12
h	m	h	m	"	"	"	"	"	"	"	"	"	"
0	0	12	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0	10	11	50	0 4	0 8	1 2	1 6	2 1	2 5	2 9	3 3	3 7	4 1
0	20	11	40	0 8	1 6	2 4	3 2	4 1	4 9	5 7	6 5	7 3	8 1
0	30	11	30	1 2	2 4	3 6	4 8	6 0	7 2	8 4	9 6	10 8	12 0
0	40	11	20	1 6	3 1	4 7	5 3	7 3	8 4	11 0	12 6	14 2	15 7
0	50	11	10	1 9	3 9	5 0	7 8	9 7	11 8	13 6	15 5	17 4	19 1
1	0	11	0	2 3	4 6	6 9	9 2	11 5	13 7	16 0	18 3	21 6	23 9
1	10	10	50	2 6	5 3	7 9	10 5	13 2	15 8	18 1	21 1	23 7	26 1
1	20	10	40	3 0	5 9	8 9	11 9	14 8	17 3	20 7	23 7	26 7	29 6
1	30	10	30	3 3	6 6	9 9	13 1	16 4	19 7	23 0	26 2	29 5	32 7
1	40	10	20	3 6	7 2	10 8	14 4	17 9	21 5	25 1	28 7	32 5	35 9
1	50	10	10	3 9	7 8	11 6	15 5	19 1	23 5	27 2	31 1	34 9	38 2
2	0	10	0	4 2	8 3	12 5	16 7	20 4	25 0	29 1	33 5	37 5	41 7
2	10	9	50	4 4	8 9	13 3	17 8	22 4	26 6	31 1	35 5	39 9	44 1
2	20	9	40	4 7	9 4	14 1	18 8	23 5	28 1	32 9	37 6	42 3	46 5
2	30	9	30	4 9	9 9	14 8	19 8	24 7	29 7	34 6	39 6	44 5	49 0
2	40	9	20	5 2	10 4	15 6	20 7	25 9	31 1	36 3	41 5	46 7	51 9
2	50	9	10	5 4	10 8	16 2	21 6	27 1	32 5	37 9	43 3	48 7	54 1
3	0	9	0	5 6	11 2	16 7	22 5	28 1	33 7	39 4	45 0	50 6	56 2
3	10	8	50	5 8	11 7	17 5	23 3	29 1	35 0	40 8	46 6	52 4	58 3
3	20	8	40	6 0	12 0	18 1	24 1	30 1	36 1	42 1	48 1	54 2	60 2
3	30	8	30	6 2	12 4	18 6	24 8	31 0	37 2	43 4	49 6	55 8	62 0
3	40	8	20	6 4	12 7	19 1	25 5	31 8	38 2	44 6	50 9	57 3	63 7
3	50	8	10	6 5	13 0	19 6	26 1	32 6	39 1	45 7	52 2	58 7	65 2
4	0	8	0	6 7	13 3	20 0	26 7	33 3	40 0	46 7	53 3	60 0	66 7
4	10	7	50	6 9	13 8	20 8	27 7	34 6	41 5	48 4	55 4	62 3	69 2
4	20	7	40	7 1	14 1	21 4	28 5	35 6	42 8	49 9	57 0	64 2	71 3
4	30	7	30	7 3	14 6	21 9	29 2	36 5	43 7	51 0	58 3	65 6	72 9
4	40	7	20	7 4	14 8	22 2	29 6	37 0	44 4	51 9	59 3	66 7	74 1
4	50	7	10	7 5	15 0	22 5	29 9	37 4	44 9	52 3	59 8	67 3	74 8
5	0	7	0	7 5	15 0	22 5	30 0	37 5	45 0	52 5	60 0	67 5	75 0

Ap. time after noon or midnight		Second Difference											
		10"	20"	30"	40"	50"	1"	2"	3"	4"	5"	6"	7"
h	m	h	m	"	"	"	"	"	"	"	"	"	"
0	0	12	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
0	10	11	50	0 1	0 1	0 2	0 3	0 3	0 0	0 0	0 0	0 0	0 0
0	20	11	40	0 1	0 3	0 4	0 5	0 7	0 0	0 0	0 0	0 1	0 1
0	30	11	30	0 2	0 4	0 6	0 8	1 0	0 0	0 0	0 1	0 1	0 1
0	40	11	20	0 3	0 5	0 8	1 0	1 3	0 0	0 1	0 1	0 1	0 2
0	50	11	10	0 3	0 6	1 0	1 3	1 6	0 0	0 1	0 1	0 2	0 2
1	0	11	0	0 4	0 8	1 1	1 5	1 9	0 0	0 1	0 1	0 2	0 2
1	10	10	50	0 4	0 9	1 3	1 8	2 2	0 0	0 1	0 1	0 2	0 3
1	20	10	40	0 5	1 0	1 3	2 0	2 5	0 0	0 1	0 1	0 2	0 3
1	30	10	30	0 5	1 1	1 6	2 2	2 7	0 1	0 1	0 2	0 3	0 4
1	40	10	20	0 6	1 2	1 7	2 4	3 0	0 1	0 1	0 2	0 3	0 4
1	50	10	10	0 6	1 3	1 9	2 6	3 2	0 1	0 1	0 2	0 3	0 4
2	0	10	0	0 7	1 4	2 1	2 8	3 5	0 1	0 1	0 2	0 3	0 4
2	10	9	50	0 7	1 5	2 2	3 0	3 7	0 1	0 1	0 2	0 3	0 4
2	20	9	40	0 8	1 6	2 3	3 1	3 9	0 1	0 2	0 2	0 3	0 4
2	30	9	30	0 8	1 6	2 5	3 3	4 1	0 1	0 2	0 3	0 4	0 5
2	40	9	20	0 9	1 7	2 6	3 5	4 3	0 1	0 2	0 3	0 4	0 5
2	50	9	10	0 9	1 8	2 7	3 6	4 5	0 1	0 2	0 3	0 4	0 5
3	0	9	0	0 9	1 9	2 8	3 7	4 7	0 1	0 2	0 3	0 4	0 5
3	10	8	50	1 0	1 9	2 9	3 9	4 9	0 1	0 2	0 3	0 4	0 5
3	20	8	40	1 0	2 0	3 0	4 0	5 0	0 1	0 2	0 3	0 4	0 5
3	30	8	30	1 0	2 1	3 1	4 1	5 2	0 1	0 2	0 3	0 4	0 5
3	40	8	20	1 1	2 1	3 2	4 2	5 3	0 1	0 2	0 3	0 4	0 5
3	50	8	10	1 1	2 2	3 3	4 3	5 4	0 1	0 2	0 3	0 4	0 5
4	0	8	0	1 1	2 2	3 3	4 4	5 6	0 1	0 2	0 3	0 4	0 5
4	10	7	50	1 2	2 3	3 5	4 6	5 8	0 1	0 2	0 3	0 5	0 6
4	20	7	40	1 2	2 4	3 6	4 8	5 9	0 1	0 2	0 4	0 5	0 6
4	30	7	30	1 2	2 4	3 6	4 9	6 1	0 1	0 2	0 4	0 5	0 6
4	40	7	20	1 2	2 5	3 7	5 0	6 2	0 1	0 2	0 5	0 6	0 7
4	50	7	10	1 2	2 5	3 7	5 0	6 2	0 1	0 2	0 5	0 6	0 7

TABLE XLVI. Latitudes and Longitudes.

249

This Table contains the LATITUDES and LONGITUDES of the most remarkable Harbours, Islands, Shoals, Capes, &c. in the WORLD, founded on the latest and most accurate Astronomical observations, surveys and charts.

The Longitudes are reckoned from the meridian of Greenwich.

I. COAST OF THE UNITED STATES OF AMERICA.		Lat.		Long.		Lat.		Long.	
		D.	M.	D.	M.	D.	M.	D.	M.
ENTRANCE of St Croix River		45	7N	67	SW				
Island of Campo-Bello (middle or West passage of Passamaquoddy Bay)		44	57	66	54				
Wolves' Islands		45	4	66	41				
E. end of Grand-Manan		44	47	66	43				
Grand-Manan N. head		44	53	66	45				
do. West end		44	40	66	55				
Pittsman Light		44	25	67	40				
Entrance of Machias River		44	44	67	20				
Gouldsboro' Harbour		44	34	67	52				
Mount Desert Rock		43	52	68	9				
Long-Island (south of Mount Desert or entrance of Blue-Hill Bay)		44	9	69	31				
Isle of Holt		44	00	69	40				
Castine		44	24	69	46				
Matinicus Island		43	50	69	55				
Wooden Bald Rock		43	45	69	51				
Island of Manhegin		43	41	69	15				
Penmaquid Point		43	48	69	27				
Bantam Ledges		43	42	69	33				
Kennebeck River entrance		43	43	69	47				
Seguine Island light		43	41	69	46				
Cape Small point		43	40	69	52				
Casbo's Ledge (shoalest part)		43	4	69	11				
Alden's Ledge (off Cape Elizabeth)		43	28	70	9				
Brunswick		43	52						
PORTLAND light-hou.		43	39	70	17				
Cape Elizabeth		43	33	70	15				
Saco River entrance		43	23	70	26				
Wood Island L. House		43	27	70	23				
Agamenticus Hill		43	16	70	41				
Cape Porpoise		43	21	70	26				
Wells Harbour		43	19	70	33				
Bald Head		43	13	70	35				
Cape Neddock Nubble		43	10	70	36				
York River		43	7	70	33				
York Ledge		43	6	70	34				
Boon Island light		43	6	70	31				
Boon Island Ledge		43	4	70	27				
PORTSMOUTH light-house		43	4	70	41				
Portsmouth		43	5	70	46				
Isles of Shoals light		42	56	70	38				
NEWBURYPORT light on Plum Island		42	48	70	51				
Spawick entrance		42	43	70	49				
Squam light		42	42	70	41				
Sandy Cove (or Bay)		42	41	70	38				
CAPE ANN light houses on Thatcher's Island		42	40	70	34				
East point of Cape Ann Harbour		42	37	70	39				
Light houses on Baker's Island		42	34N	70	47W				
Beverly		42	34	70	52				
SALEM		42	33	70	52				
Marblehead		42	32	70	50				
Nahant Point (N. E. Point of Boston harbour)		42	23	70	54				
Boston light-house		42	20	70	54				
BOSTON		42	23	71	4				
CAMBRIDGE (Mass.)		42	23	71	8				
Scituate light		42	11	70	41				
Plymouth lights		41	59	70	34				
Race Point light		42	6	70	14				
CAPE COD light		42	5	70	4				
Chatham light		41	43	69	56				
Sandy Point or Malabar		41	34	69	59				
Shoal of George.									
Great Shoal S. E. P.		41	34	67	40				
do. do. W. P.		41	42	67	59				
do. do. N. E. P.		41	48	67	47				
do. North Shoal		41	53	67	43				
do. Third Shoal		41	51	67	26				
do. East Shoal		41	47	67	19				
NANTUCKET light-house		41	23	70	00				
Sanctity head on Nantucket Island		41	16	69	58				
Tom Nevers head		41	14	69	59				
Nantucket South Shoal (true lat. by Blunt)		41	4	69	55				
Cape Poge, (Vineyard)		41	25	70	25				
Squibnocket-head (southwesterly part of Martha's Vineyard)		41	17	70	48				
Gay Head light-house, (Vineyard)		41	21	70	50				
Norman's Land Island		41	15	70	49				
New-Bedford light hou.		41	35	70	53				
Bozzard's Bay entrance		41	28	70	50				
NEWPORT		41	29	71	18				
Rhode Island light-hou.		41	28	71	23				
Point Judith L. house		41	24	71	29				
Watch Hill P. light		41	20	71	53				
Little Gull light		41	14	72	10				
Block Island		41	10	71	38				
New-London (or entrance of Thames river) light-house		41	21	72	11				
Falkland Island L. house		41	15	72	45				
NEW-HAVEN entrance		41	17	72	58				
Montock Point (E. end of Long-Island) light-house		41	4	71	55				
East Hampton in do.		41	00	72	16				
NEW-YORK City		40	42	74	00				
New-York light-house on Sandy Point		40	28	74	1				
Perth Amboy		40	30	74	30				
Little Egg Harbour		39	30	74	22				
Great Egg Harbour		39	18	74	34				
Cape May		38	57	74	58				
PHILADELPHIA		39	57	75	9				
Light-house on Cape Henlopen		38	47	75	7				

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Virginia and Maryland.	Cape Charles . . .	37	7N	76 15W	East Coast of Florida.	Muskito or N. Smyrna entrance . . .	28 52N	80 56W	
	Cape Henry light . . .	36	56	76 18		Cape Canaveral . . .	28 19	80 33	
	Norfolk (Vir.) . . .	36	53	76 34		Outer breakers off do. . .	28 20	80 13	
	Petersburgh (Vir.) . . .	37	12	77 44		Las Tortolas or Hummocks . . .	27 35	90 30	
	York Town (Vir.) . . .	37	12	76 39		Hillshorough Isl. N. P. . .	27 31	90 19	
	RICHMOND (Vir.) . . .	37	30	77 44		— S. P. . .	27 16	80 13	
	Annapolis (Mar.) . . .	39	00	76 37		Mount Pelado or Bald Head . . .	27 1	80 11	
	ALEXANDRIA (Vir.) . . .	38	49	77 4		Grenville's Inlet . . .	26 47	80 2	
	WASHINGTON City . . .	38	53	77 2		Cooper's Hill . . .	26 42	80 3	
	Chincoteague Shoals (on Maryland shore) . . .	37	58	75 15		Sand Hills . . .	26 32	80 3	
	BALTIMORE . . .	39	23	76 39		New Inlet . . .	26 17	80 6	
	Roanoke Inlet . . .	35	50	75 35		Middle River entrance . . .	26 7	80 7	
	CAPE HATTERAS . . .	35	14	75 30		CAPE FLORIDA . . .	25 42	90 9	
	Extreme shoal off do. . .	35	3	75 23		Aliol. N. P. . .	25 20	90 20	
	Deep soundings off do. . .	34	56	75 9		Cuyo Largo or Long Key, N. E. P. . .	24 57	90 35	
	Ocracock Inlet . . .	35	1	75 59		— S. E. P. . .	24 52	80 34	
	Cedar Inlet . . .	34	47	76 22		Sombrero or Hat Key . . .	24 32	91 23	
	CAPE LOOKOUT . . .	34	34	76 37		Looe Key . . .	24 28	81 37	
	Extreme shoal off do. . .	34	21	76 32		Samboes . . .	24 25	81 47	
	Deep soundings off do. . .	34	7	76 12		Sand Key or C. Arena . . .	24 21	81 59	
North-Carolina.	Old Topsail Inlet . . .	34	39	76 46	South Coast of Florida.	S. W. end of shoals off C. Florida . . .	24 20	82 31	
	Beaufort (N. C.) . . .	34	42	76 46		Tortugas Islands and Banks. N. W. part . . .	24 34	83 2	
	Cheesman's Inlet . . .	34	41	76 51		— N. E. do. . .	24 37	82 45	
	Bouge Inlet . . .	34	38	77 14		— S. E. do. . .	24 33	82 45	
	Swanborough . . .	34	41	77 17		— S. W. do. . .	24 25	83 00	
	Bear Inlet . . .	34	36	77 21		Key Marquis . . .	24 30	82 13	
	New River Inlet . . .	34	34	77 30		Boca Grande or Great Mouth . . .	24 32	82 11	
	Stump Inlet . . .	34	31	77 37		Key Samba . . .	24 35	91 53	
	New Topsail Inlet . . .	34	27	77 44		Island of Pines . . .	24 42	91 41	
	Sandy Inlet . . .	34	19	77 55		Keys of Bay Honda . . .	24 44	91 29	
	Deep Inlet . . .	34	14	78 00		Key Vacas . . .	24 41	81 17	
	WILMINGTON . . .	34	17	78 10		Key Agi . . .	24 49	91 16	
	Brunswick . . .	34	3	78 10		Cape Sable or Tancha . . .	24 50	81 19	
	Smithville . . .	33	54	78 13		Cape Romano or P. Larga . . .	26 00	81 51	
	New Inlet . . .	33	57	78 6		Boca Grande ent. B. Carlos . . .	26 41	82 10	
	CAPE FEAR . . .	33	48	78 9		Boca Serraxota . . .	27 16	92 37	
	Extreme shoal off do. . .	33	36	77 47		Spirito Santo Bay ent. . .	27 38	92 47	
	Deep soundings off do. . .	33	11	77 26		Keys Ancote . . .	28 11	83 7	
	Lockwood's Folly Inlet . . .	33	53	78 25	West Coast of Florida.	Keys of St. Martin . . .	28 42	93 1	
South-Carolina.	Shallot . . .	33	51	78 39		Fresh water Keys . . .	29 8	83 5	
	Little River Inlet . . .	33	50	78 49		Cayos de Cedres . . .	29 23	83 5	
	GEORGETOWN . . .	33	25	79 00		St. Marcos de Apalache . . .	30 9	94 19	
	Ditto light . . .	33	13	78 55		South Cape . . .	29 48	84 29	
	Shoals off do. . .	33	8	78 42		St. George's Key, S. P. . .	29 30	85 18	
	Cape Roman . . .	33	2	79 6		Cape St. Blas . . .	29 36	85 35	
	CHARLESTON . . .	32	46	79 48		Bay St. Andres (E. point of Island Rosa) . . .	30 21	86 43	
	Charleston light-house . . .	32	40	79 40		Bay St. Rosa (W. point of do.) . . .	30 19	97 31	
	North Eddisto Inlet . . .	32	30	79 59		PENSACOLA . . .	30 24	87 27	
	South Eddisto Inlet . . .	32	23	80 7		River Perdido . . .	30 18	87 46	
	BEAUFORT (S. C.) . . .	32	28	80 33		Mobile Point . . .	30 13	98 21	
	Port Royal entrance . . .	32	8	80 27		MOBILE . . .	30 40	98 21	
	Tybee light . . .	32	00	80 49		Massacre Island . . .	30 12	98 37	
	SAVANNAH . . .	32	2	81 3		I. del Cuerpo . . .	30 12	98 49	
	St. Catherine's Sound . . .	31	37	81 13		Candelarius, N. P. . .	29 59	98 57	
	St. Simon's Sound . . .	31	1	81 36		— S. P. . .	29 28	99 12	
	Brunswick (Geo.) . . .	31	10						
E. C. of Florida.	Amelia Sound (entrance of St. Mary's river) . . .	30	44	81 43					
	Cumberland Isl. (S. P.) . . .	30	43	91 35					
	Amelia Island (S. P.) . . .	30	28	81 36					
	River Nassau entrance . . .	30	28	81 35					
	River St. John entrance . . .	30	21	81 35					
	St. Augustine . . .	29	51	81 28					
	Island Anastasia, N. P. . .	29	51	81 23					
	— S. P. . .	29	37	81 17					

TABLE XLVI. Latitudes and Longitudes.

251

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Key Breton	29	28N	89	18W	St. Christ's or St. Kitts				
Entrance of MISSIS-					— N. W. point	17	24N	62	51W
SIPPI, N. E.	29	12	89	9	St. Eustatia Town	17	29	63	2
— La Balise	29	8	89	6	Saba	17	40	63	16
— S. E.	28	59	89	13	Aves or Bird's I. about	15	40	63	40
— S. W.	28	56	89	29	Barbuda, N. P.	17	44	61	50
NEW-ORLEANS	29	57	90	9	St. Bartholomew, E. P.	17	54	62	40
Baton Rouge	30	36	91	13	St. Martin's, E. P.	18	4	63	1
Long-Island	29	15	90	14	Anguilla, S. W. point	18	12	63	8
I. Tonbalie, S. P.	28	59	90	39	— N. E. do.	18	18	62	52
I. del Vino W. end	28	56	91	24	Prickly Pear	18	20	63	15
Banco de Hostiones,					Ile of Dogs, western	18	19	63	20
— S. P.	28	50	91	44	Sombrero	18	38	63	30
— W. P.	29	26	93	4	St. Croix or St. Cruz E. P.	17	45	64	34
Iron Point or Point Fi-					— W. P.	17	42	64	54
erro	29	14	92	7	Anegado, S. P. of shoal	18	36	64	9
Deer Point	29	26	92	29	— W. P.	18	46	64	23
Point del Pajaro	29	24	92	48	Virgin Gorda, E. P.	18	30	64	18
River Lobos, ent.	29	32	93	4	Tortola, E. P.	18	28	64	31
Salt water Bay	29	26	93	28	— W. P.	18	25	64	42
Constant Bay	29	27	93	39	St. John's	18	22	64	42
River Mermentau	29	38	94	11	St. Thomas	18	22	64	55
Point ent. river Sabine	29	40	94	57	Bird Key	18	15	64	50
II. Islands in the West Indies.					Serpent I. E. part	18	19	63	17
					— Crab I. E. part	19	10	63	15
TRINIDAD,					Cape St. John or N. E.	18	24	66	35
— Spanish Town	10	39N	61	30W	PORTO RICO	18	29	66	5
— Icaque Point	10	4	61	55	Point Bruggen or N. W.	18	31	67	7
— Point Galote	10	9	60	55	Point St. Francisco	18	22	67	13
— Point Galera	10	51	60	51	Cape Roxo or S. W. P.	17	58	67	9
Tobago, N. E. Point	11	29	60	17	Los Morillos	18	00	67	16
— S. W. point	11	5	60	48	Point Coama	17	55	66	27
Grenada, N. E. point	12	19	61	40	C. Mala Pasqua or SE. P.	17	59	66	47
— S. W. point	11	58	61	52	Shoal	19	20	66	50
Grenada Bank Middle	11	55	62	18					
Barbadoes, S. P.	13	1	59	36	Muertos Island	17	52	66	30
— E. do.	13	8	59	24	La Moon I.	18	6	67	30
— Bridgetown	13	5	59	41	Monito I.	18	9	67	53
— N. W. point	13	18	59	41	Zachco or Dessochco I.	18	24	67	26
St. Vincent, N. point	13	12	61	21					
— S. do.	13	4	61	20	Cape Engano	18	35		
St. Lucia, S. point	13	30	61	00	Saona I. E. part	18	13	68	31
— N. do.	13	56	60	56	St. Catherine's I.	18	18	68	58
Martinico, S. E. point	14	24	60	56	St. Domingo	18	28	69	51
— Diamond Rock	14	24	61	6	La Catalina	18	8	70	11
— Port Royal	14	36	61	9	Cape Beata	17	42	71	20
— Macouba Point	14	56	61	28	Altavela rock off do.	17	28	71	21
Dominica, S. point	15	14	61	29	Cape Jacquemel	18	13	72	35
— N. do.	15	39	61	30	Island Bac	18	4	73	38
The Saints Island	15	52	61	37	Point Gravois	18	00	73	55
Mariagalante, N. P.	16	4	61	14	Cape Tiberon	18	20	74	29
— S. do.	15	53	61	15	Navaza Island	18	24	75	3
Guadeloupe, S. W. P.	15	58	61	42	Cape Donna Maria	18	38	74	27
— N. W. do.	16	20	61	56	Jeremy	18	39	74	7
— N. E. do.	16	30	61	32	Caymito	18	39	73	43
— S. E. do.	16	11	61	15	Petit Guave	18	25	72	54
Desade	16	21	61	9	Leogane	18	29	72	38
Antigua, E. P.	17	5	61	44	PORT-AU-PRINCE	18	33	72	21
— W. point	17	5	62	00	I. Gonave, S. E. P.	18	42	72	47
Montserrat, S. P.	16	42	62	17	— N. W. P.	19	56	73	19
— N. P.	16	50	62	17	St. Mark	19	4	72	45
Redonda Island	16	56	62	22	St. Nicholas Mole	19	49	73	25
Neris	17	9	62	33	Tortugas W. P.	20	6	72	54
St. Christ's or St. Kitts					— E. P.	20	2	72	35
— S. E. point	17	12	62	38	CAPE FRANCOIS	19	45	72	13

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Jamaica.	Port Dauphin	19 42N	71 55W		Los Colorados, S. W. P.	22 19N	84 44W		
	Shoal off M. Christe	20 2	71 40		— N. E. P.	22 58	83 8		
	Monte Christo	19 54	71 43		Point Juan and Jaunito	22 22	84 21		
	Point Isabella	19 58	71 10		Hill Guajibon	22 18	83 21		
	Old Cape Francois	19 40	69 55		Bay Honda	22 54	83 5		
	Cape Samana	19 16	69 7		Port Cabanas	22 58	82 52		
	Cape Raphael	19 3	68 53		MARIEL	23 1	82 45		
					River Banco	23 4	82 38		
	Morant, E. P.	17 58	76 9		HAVANNAH (the				
	KINGSTON	18 1	76 51		Moro)	23 9	82 19		
	Port Royal	17 59	76 55		Point Escondido	23 8	81 47		
	Portland Point	17 42	77 14		Point Guanos	23 9	81 40		
	Pedro Bluffs	17 50	77 55		Pan of Matanzas	23 2	81 42		
	Black River	18 1	78 1		MATANZAS	23 2	81 36		
	Savannah la-Mar	18 13	78 23		Point Yeacos	23 8	81 9		
South side of Cuba.	Cape Negril, S. point	18 14	78 37		Stone Key off do.	23 12	81 9		
	— N. do.	18 24	78 35		Key Cruz del Padre	23 14	80 55		
	Montego Bay	18 31	78 9		Las Cabezas	23 16	80 43		
	Martha Brae	18 31	77 49		Nicholas shoal	23 10	80 13		
	St. Ann's	18 31	77 22		Key Carenero	22 51	79 49		
	Galina Point	18 29	76 59		Key Francis	22 40	79 17		
	Arnatta Bay	18 21	76 51		Key William (northern-				
	N. E. Point	18 13	76 20		most)	22 36	78 34		
					St. Juan	22 14	78 58		
	Morant Keys or Las				Key Coco S. side Baha-				
	Ranas	17 25	76 00		ma channel	22 29	78 17		
	Pedro Shoals				Key Point Paredon do.	22 30	79 5		
	— Portland R. N. E. P.	17 00	77 13		The Barrel	22 25	77 56		
	— Rattlesnake, N. W.				Cayo Confites	22 11	77 40		
	P.	17 5	79 13		Cayo or Key Verde	22 5	77 37		
Caycos I.	— South part	16 43	78 26		Guajava	21 54	77 25		
	Formigas Shoal, N.E.P.	18 34	75 42		Point Maternillos	21 40	76 59		
	— S. W. P.	18 28	75 51		Point de Mangle	21 13	76 14		
	Little Cayman, S. W. P.	19 36	80 5		Point de Mulas	21 7	75 34		
	Caymanbraek, E. P.	19 43	79 52		Tanamo	20 43	75 13		
	Grand Cayman, S.W.P.	19 16	81 5		Key Moa	20 44	74 49		
	— E. P.	19 18	80 37		Point Guarico	20 40	74 41		
	Swan Islands	17 21	84 4		Baracoa	20 22	74 25		
	New shoal	15 56	79 8						
	Navaza	18 24	75 3		Shoal	19 56	69 5		
					Nativity bank or E. reef	20 8	68 41		
	Cape Mayze	20 14	74 4		Superb shoal	20 58	68 79		
	C. Bueno or Guanos	20 6	74 12		Silver Key, S. E. end	20 15	69 29		
	Point ent. Cumberland				— N. E. do.	20 32	69 27		
	Har.	19 54	75 11		— W. do.	20 29	69 59		
Caycos I.	St. JAGO DE CUBA,				Square Handkerchief,				
	entrance	19 57	76 5		N. E. P.	21 20	70 23		
	Tarquin's Peak	19 54	76 50		— S. E. P.	20 56	70 25		
	Cape Cruz	19 47	77 42		— S. W. P.	20 53	70 56		
	Boca del este	20 19	79 8		Turk's-Island, Grand T.	21 30	71 3		
	Key Breton	21 6	79 55		— Salt Key	21 20	70 52		
	Trinidad river	21 44	80 5		— Sand Key	21 12	71 10		
	Bay Xagua	21 53	80 48		— Endymion's Rocks	21 7	71 15		
	Stone Keys	21 47	81 45		Great Caycos, south				
	Los Jardines	21 37	81 31		Part	21 31	71 27		
	S. E. point of the Bank	21 24	81 18		— N. E. P. or shoal				
	El Jardinillo	21 24	81 50		St. Philip	21 45	71 22		
	Keys Jardines	21 24	82 4		— N. W. part	21 54	71 47		
	N. Pines, S. W. P.	21 22	82 55		North Caycos, middle	21 56	71 57		
	Indian Keys	21 29	82 56		Booby Rocks off do.	21 58	71 57		
	Keys St. Philip	21 48	83 6		Providence Caycos, N.				
	Point Piedras	21 48	83 42		W. P.	21 52	72 21		
	Cape Corientes	21 43	84 23		Little Caycos, S. W. P.	21 36	72 27		
	Cape St. Antonio	21 54	84 57		Key Francis	21 31	72 7		
	Sancho Pedro Shoal	22 4	85 28		Sand Key	21 18	72 3		
	Shoal discovered in 1797	22 6	85 2		South Keys shoal	21 1	71 43		

TABLE XLVI. Latitudes and Longitudes.

950

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Great Inagua or Hene- aga, N. E. P.	31 19N	73 1W	Leeward Stocking I. . .	23 50N	76 10W
— S. E. P.	31 00	73 6	THE HOLE IN THE WALL.	25 51	77 13
— S. W. P.	30 54	73 41	Rocky point of Abaco . .	26 14	77 5
— N. W. P.	31 8	73 41	Elbow Key	26 31	77 00
Little Heneaga, E. P. .	31 29	72 55	Man of War Key	26 36	77 5
— W. P.	31 28	73 7	Great Guano Key	26 43	77 11
Hogstues or Corrolaes Bank	31 39	74 00	Los Galapagos, N. P. . .	27 22	78 21
Mayaguana E. Reef . .	22 17	72 39	Lit. Bahama Bank, N.P. .	27 50	79 11
— N. do.	22 30	73 6	Memory Rock	26 58	79 4
— S. W. point	22 20	73 11	Sand Key	26 54	79 1
French Keys or I. Pla- nas	22 40	73 34	Wood Key, or C. Leno . .	26 46	79 00
Miraporvos Keys . . .	22 7	74 32	Great Bahama I. W. P. .	26 38	78 55
Castle Island or South Key	22 8	74 20	— S. P.	26 21	78 35
Fortune Island, W. P. .	22 30	74 20	— E. P.	26 19	78 9
North Key, Bird I. . .	22 50	74 22	Dog Keys, N. P.	24 1	79 45
Crooked Island, W. P. .	22 48	74 18	Water Key	23 58	79 57
— E. P.	22 38	73 50	Double-headed Shot Key, Western	23 52	80 14
Atwood's Keys, or I. hamana, E. P.	23 5	73 35	Salt Key	23 39	80 8
— W. P.	23 3	73 49	Anguila, E. P.	23 27	79 14
Rum Key	23 34	74 57	Bermuda		
Watland's I. N. E. P. .	24 6	74 26	— GEORGETOWN,	32 22	64 33
— S. . P.	23 57	74 37	— Wreck Hill, western- most-land	32 15	64 50
Conception, or Little I. .	23 52	75 16	Best Latitude to run for Bermuda	32 8	
St. Salvador, or Guana- hara S. P.	23 57	75 32			
— S. P.	24 33	75 49			
Little St. Salvador, N.P.	24 32	76 12			
Eleuthera or Hetera I .					
— Powell's Point, S. P. .	24 38	76 23			
— Point Palmeto	25 12	76 26			
— James Point	25 24	76 36			
Harbour Island	25 29	76 50			
Egg Island, W. P. . . .	25 28	77 6			
New Providence					
— NASSAU	25 5	77 22			
— E. P.	24 59	77 9			
— W. P.	24 59	77 35			
Andros Islands, S. P. .	24 4	77 45			
— N. P.	25 24	78 3			
Berry Islands, Eastern .	25 22	77 41			
— Northern	25 49	78 1			
— Great Harbour	25 49	78 5			
Little Isaac, Eastern . .	25 57	78 46			
Great Isaac	26 1	79 2			
Bimini Island, northern fresh water key	25 43	79 8			
Cat Key	25 23	79 10			
Riding Rocks	25 17	79 4			
Orange Keys, North . .	24 58	79 6			
— South	24 53	79 6			
Key Guinchon	22 44	78 1			
Key Lobos	22 25	77 33			
Las Mucanas	22 10	77 12			
South edge of the Bank .	23 5	76 22			
Key St. Domingo	21 45	75 45			
St. Vincent's Shoal . . .	21 56	75 19			
Key Verde Island	22 1	75 5			
Key Sal	22 12	75 41			
Yuma or Long I. S. P. .	22 49	74 46			
— N. P.	23 30	75 19			
Exuma, N. W. P.	23 36	75 51			

TABLE XLVI. Latitudes and Longitudes.

255

	Lat.	Long.		Lat.	Long.
	D. M.	D. M.		D. M.	D. M.
PORTO BELLO	9 33N	79 35W	New Barcelona	10 28N	64 46W
Farallon I. N. P.	9 40	79 33	I. Borracho	10 20	64 48
Point Manzaniello	9 38	79 20	Sante Fe	10 16	64 31
Point St. Blas	9 33	78 40	Cumana	10 27	64 15
Point Conception	9 19	77 53	Arya	10 35	64 20
I. e of Pines	8 55	77 39	Morro Chocopata	10 42	63 54
Cape Siboron	8 40	77 29	Escondido or Hidden		
River Suniquilla, ent.	7 57	76 54	Port	10 41	63 27
Point Carabana	9 37	76 57	Cape Malapascua	10 42	63 4
Point Arboletes	8 49	76 32	Cape Three Points	10 46	62 44
Island Fuerte	9 20	76 13	Point Galera	10 45	62 33
I. Bernard, N. W. P.	9 48	75 50	Point Pena or Salina	10 44	61 53
CARTHAGENA	10 25	75 29	Dragon's Mouth	10 41	61 48
Island de Samba	10 48	75 20	River Gaurapiche, ent.	10 12	62 43
West ent. River Mag-			Point Morro	9 54	61 58
dalen	11 3	74 56	Oronoco River	8 25	60 26
St. Martha	11 15	74 11	Cape Barma	8 22	60 4
Cape Aguja	11 21	74 12	Essequibo River	7 00	58 20
Bank Navio quebrado	11 36	73 11	DEMERARA river, ent.		
Hacha	11 31	72 56	Corrobano Point	6 49	57 58
Cape la Vela	12 11	72 14	River Berbice, Ent.	6 20	57 11
Point Galinas	12 27	71 41	SURINAM River, ent.	5 53	55 15
Monges Islands, N. P.	12 31	70 59	Paramaribo	5 49	55 15
Cape Chichibacoa	12 17	71 17	R. Marouri, entrance	5 50	53 52
Point Espada	12 5	71 8	CAYENNE	4 56	52 15
St. Carlos	11 3	71 12	Oyapock River, St Louis	3 51	51 40
BARACAYBO	10 43	71 17	Cape Orange	4 12	51 20
Point Cardon	11 24	69 46	R. Cassipour, entrance	3 54	51 10
Point Macolla	12 6	70 19	Cape North	1 48	50 10
Cape St. Roman	12 12	70 7	Mouth of River Amazon	0 18	50 00
Island Oruba, N. W. P.	12 39	70 9	Cape Magoany	0 17S.	47 56
— S. E. P.	12 25	69 58	Point Tagioca	0 33	47 28
Point Aricula	11 57	69 53	Para	1 28	47 58
Point Sarannos	11 33	69 10	Bay Maracuno	0 37	47 10
Point Soldado	11 14	68 35	Caste Harb.	0 47	46 33
Key Borrocho	10 57	68 19	Cape Gurapi	0 42	45 22
Tucacas	10 51	68 17	Shoal	0 52	43 40
PORTO CABELLO	10 29	68 4	Island of St. Joao	1 17	44 13
Valencia	10 18	68 7	Bay of Mt. Luis	1 5	43 18
Point St. John Andre	10 30	67 48	Bay de Cabalo de Velha	1 30	43 54
Point Oricaro	10 34	67 17	Point of B. Atius	2 3	43 44
Point Trincher	10 32	67 4	Itaculumi	2 7	43 50
LA GUIRA	10 37	66 59	S. Marcos	2 27	43 40
CARRACCAS	10 30	66 57	Va. de Alacantara	2 22	43 47
Centinela I. or White			St. Luis de Maranham	2 29	43 40
Rock	10 50	66 6	Coroa Grande, or Great		
Cape Codora	10 36	66 3	Crown Banks, N. E.		
Curacao I. N. P.	12 24	69 13	Point	2 12	43 18
— S. E. P.	12 2	68 36	Fin dos Lancos Grandes	2 19	42 40
Little Curaco	11 59	68 41	I. St. Anna	2 18	43 5
Buenayre, N. P.	12 21	68 26	Bay of Rio Perguicas	2 23	42 4
— S. P.	12 2	68 18	Iguarazu ent. Parnhaiba	2 44	41 20
Birds or Aves I. western	12 00	67 42	Jericoacoara	2 44	40 15
Eastern	11 58	67 29	Corno de Caracu	2 48	39 44
Roca, W. P.	11 51	66 59	Mount Melancia Point	3 7	39 7
— E. P.	11 51	66 32	Searra	3 32	38 27
Orchilla I.	11 49	66 5	Bay Iguaque	3 40	38 14
Blanca I.	11 52	66 40	Rocas (dangerous)	3 53	38 26
Portaga I.	10 57	65 19	St. Lorenzo	3 57	37 52
Seven Brothers mid.	11 46	64 27	Point Daniel	3 42	37 24
Margarita, W. P.	11 2	64 28	Baxos de Salino	4 40	37 00
— E. P.	11 00	63 50	Point Pedras	3 52	36 38
I. Cuagua or Pearl I.	11 43	64 14	Cape St. Roque	5 8	35 38
Friars I.	11 14	63 38	River Parahiba, ent.	6 48	35 10
I. Sola	11 20	63 38	I. Tamarica	7 46	35 20
Testigos I.	11 24	63 9	Pernambuco	8 11	35 2
River Orquilla ent.	10 8	65 32	Cape St. Augustine	8 51	34 51
			Rio St. Francisco	10 57	35 4

	Lat.		Long.			IV. West Coast of America from Cape Horn to Icy Cape.			
	D.	M.	D.	M.		Lat.	Long.	D.	M.
Brazil.	ST. SALVADOR (Cape St. Antonio)		13	18	38 32W	Terra del Fuego.	CAPE HORN	55 59S.	67 21W
	I. das Ilhas		14	52	38 50		I. Diego Ramirez S. part	56 32	68 36
	Porto Seguro		16	40	39 00		— N. part	56 25	68 45
	Abrohos Islands		18	00	38 22		I. St. Ildefonso S. P.	55 56	69 17
	Espiritu Santo		20	11	39 39		Terra del Fuego		
	Cape St. Thomas		21	59	40 40		— False Cape Horn	55 42	68 8
	St. Ann's Islands		22	22	41 46		— Yorkminster	55 27	70 4
	John's Is. St. Ann's Bay		22	35	42 5		— C. Gloucester.	54 7	73 35
	Anchor Island		22	44	41 50		— Cape Pillars S. W. entrance to Magellan's Straits	52 4	74 57
	CAPE FRIO		23	1	42 6		Evangelist I. W. entr.		
	Monks Islands		22	59	42 29		Magellan's Straits	52 34	75 5
	Point Negra		23	00	42 41		Cape Victory	52 25	74 57
	Maurice Islands		23	2	42 56		Cape St Jago	50 54	75 30
	Razor I. off R. Janeiro		23	5	43 16		Cape Three Points	49 46	75 45
	Point St. Cruz		22	57	43 16		Cape Corso	49 26	75 45
	RIO JANEIRO harb.		22	52	43 18		I. Campana N. W. point	48 00	75 19
	Sugar Loaf		22	58	43 17		Cape Tres Montes	46 59	75 27
	River Guaratiba		23	10	43 39		Cape Taitaohahouon	45 51	75 28
	Point Maranbaya		23	17	43 58		I. Huafo W. part	44 00	74 42
	I. Grande S. P.		23	22	44 9		P. Quilan	43 41	74 21
	Point Joatinga		23	27	44 28		P. St. Carlos	41 49	73 53
	I. St. Sebastian, N. P.		23	36	45 2		P. Quedal	41 5	74 9
	— S. P.		23	52	45 2		P. de la Galera	39 54	73 46
	Mount Trigo		23	59	45 4		VALDIVIA, entrance	39 51	73 33
	St. Catherine's Island		27	32	48 00		P. Tirua	38 29	73 46
	Porto St. Pedro		32	9	52 2		I. de la Mocha W. part	38 20	74 3
	Cape St. Mary		34	39	53 58		St. Maria Islands N. P.	36 59	73 41
	I. Lobos		35	2	54 42		— S. P.	37 5	73 42
	Maldonado harbour		34	56	54 50		CONCEPTION, city	36 49	73 9
	Point Piedras		35	29	57 2		Talcahuano, port of do.	36 41	73 12
	MONTE VIDEO		34	54	56 4		Santiago	33 27	70 43
	BUENOS AYRES		34	37	58 24		VALPARAISO, port	33 1	71 37
	Cape St. Antonio		36	21	56 45		Point Ballena	31 50	71 44
	Cape Lobos		36	55	56 47		Coquimbo	29 56	71 19
	Cape Corrientes		37	59	57 39		Huasco	28 26	71 15
	Point de Neuva		42	55	64 9		Copiapo	27 10	71 8
	St. Helena		44	30	65 27		P. Negra	26 24	70 56
	St. George's Bay, C.						Isl. St. Felix, Eastern	26 20	79 47
	Cordova		45	45	67 25		— Western	26 16	80 3
	Cape Blanco		47	15	65 57		I. Blanca	24 56	70 36
	Point Desire		47	45	66 2		Morro Moreno	23 18	70 32
	Port St. Julian, ent.		49	7	67 42		Morro de Mexilones	23 4	70 28
	St. Cruz harbour		50	19	68 29		Point Tames	22 33	70 10
	Cape Fairweather		51	34	68 59		Jaguey de Raquiza	21 50	70 9
	Cape Virgins, northern point of entrance to Magellan's Straits		52	24	68 25		Pavellon de Pica	20 59	70 16
	Cape Espiritu Santo (south point of entrance to do.)		52	40	68 26		Point Piedras	20 5	70 13
	Terra del Fuego C. Penas		53	45	67 29		Point Pisagua	19 26	70 19
	— Cape St. Diego		54	37	65 5		Arica	18 27	70 19
	Staten Land						Point de Coles	17 42	71 14
	— C. St. John, easternmost land near C. Horn		54	48	63 42		Ilo	17 38	71 13
	— C. St. Bartholomew		54	57	64 39		Point Cornejo	16 41	72 46
	— C. del Medio entr. to Le Maire's Straits		54	49	64 48		Cumana	16 17	73 21
	New Island E. part		55	17	66 25		Atico	16 8	73 47
	Evour's Island, middle		55	32	66 47		R. St. Juan	15 15	75 14
	Bernabelas Islands, E. P.		55	44	66 46		Los Amigos Point	14 27	76 2
	CAPE HORN, South part of Hermit's Isl.		55	59	67 21		Pisco	13 46	76 12
Terra del Fuego.						Peru.	Caneta	13 1	76 27
							P. Chilca	12 33	76 43
							I. St. Lorenzo, W. P.	12 5	77 8
							LIMA	12 3	76 55
Terra del Fuego.							CALLO, sea port of Lima	12 2	77 4
							I. Pescador, W. part	11 46	77 10

TABLE XLVI. Latitudes and Longitudes.

257

	Lat.	Long.		Lat.	Long.
	D. M.	D. M.		D. M.	D. M.
<i>Peru.</i>					
Los Hornigas Islands . . .	11 56S.	77 48W	Aguasco . . .	16 2N.	96 52W
I. Pelada . . .	11 27	77 41	ACAPULCO . . .	16 55	100 54
Island St. Martin . . .	11 3	77 30	Cape Corrientes . . .	20 32	105 35
Point Santander . . .	10 39	77 41	St. Blas . . .	21 30	104 50
Rock seen in 1792 . . .	10 48	78 48	Tres Marias . . .	21 28	106 29
Ferrol (entrance) . . .	9 7	78 30	St. Joseph . . .	23 4	109 49
Truxillo . . .	8 8	78 53	Cape St. Lucas . . .	22 44	109 54
I. Malabrigo (port) . . .	7 48	79 21	Morro Hermosa . . .	27 46	114 41
Ist. Lobos de Mar . . .	6 59	80 44	Redondo Island . . .	29 49	115 10
Ist. Lobos de Tierra . . .	6 24	80 46	Bay St. Francisco . . .	30 23	115 36
Eten . . .	6 56	79 49	B. Todos Santos . . .	31 46	116 22
Point de Ajuga . . .	5 59	81 4	Port Diego . . .	32 39	116 59
Point Payta . . .	5 3	81 2	Point Conception . . .	34 32	120 6
Cape Blanco . . .	4 19	81 6	Monterey . . .	36 39	121 43
P. Malpelo . . .	3 32	80 17	Port St. Francisco . . .	37 49	122 14
GUAYAQUIL City . . .	2 12	79 42	Cape Mendocino . . .	40 19	124 7
I. Puna, S. W. P. . . .	3 4	80 8	Port Trinidad . . .	41 3	123 54
Point St. Helena . . .	2 10	80 48	Cape Blanco or Orford . . .	42 63	124 25
I. Pelado . . .	1 56	80 35	Cape Gregory . . .	43 26	124 6
Point del Callo . . .	1 23	80 34	Cape Foulweather . . .	44 52	124 00
I. de la Plata, W. P. . .	1 18	80 57	Cape Rond . . .	46 43	123 43
Cape St. Lorenzo . . .	1 4	80 43	Cape Disappointment . . .	46 19	123 59
Manta . . .	0 57	80 32	Cape Flattery . . .	48 24	124 31
Cape Pasado . . .	0 27	80 20	Breaker's Point . . .	49 24	126 26
Quito . . .	0 18	78 18	NOOTKA . . .	49 36	126 20
Arbol . . .	0 15N	79 48	Woody Point . . .	50 6	127 43
Cape St. Francisco . . .	0 39	79 52	Bay St. Louis . . .	50 34	128 14
P. de la Galera . . .	0 48	79 51	Isles de Sartine (or Scott) . . .	50 56	128 50
R. Esmeraldas entrance . . .	0 58	79 23	Cape Scott . . .	50 49	128 20
P. Mangles . . .	1 37	78 52	Cape Caution . . .	51 12	127 52
I. Tamao . . .	1 47	78 38	Cape Hector or James . . .	51 57	131 7
P. Guasama . . .	2 29	78 23	Bay de la Touche . . .	52 42	132 10
I. Gorgona middle . . .	2 53	78 7	Cape Henry . . .	52 63	132 27
River Cajambrie, ent. . .	3 19	77 3	Bay de Clouard . . .	53 52	133 21
I. de Malpelo . . .	3 55	80 4	Point North . . .	54 20	133 15
I. de Palmas . . .	3 57	77 7	Cape St. Bartolomeo . . .	55 12	133 38
P. Chirambira . . .	4 13	77 15	Cape Ommaney . . .	56 12	134 35
Cape Corrientes . . .	5 34	77 15	Port Guibert . . .	56 38	135 00
Limones . . .	6 3	77 11	Port Neckar . . .	56 43	135 4
P. St. Francisco Solano . . .	6 49	77 47	C. Engano or Edgecumbe . . .	57 2	135 50
P. Garachine . . .	8 8	78 12	Port Gaudaloupe . . .	57 10	135 43
PANAMA . . .	8 57	79 22	Port de los Remedios . . .	57 24	135 43
P. Mala . . .	7 24	79 53	Cape Cross . . .	57 57	136 24
Peurcos Point . . .	7 13	80 13	Port des Français . . .	58 37	137 20
I. Quibo, N. P. . . .	7 41	81 37	Cape Fairweather . . .	58 55	137 52
Los Ladrones . . .	7 52	82 30	Behring's Bay . . .	59 18	139 00
Point Burica . . .	8 3	82 50	Point de la Boussole . . .	59 50	140 55
Gulfe Dulce, W. P. . .	8 23	83 18	Mount St. Elias . . .	60 23	140 45
I. Cano ent. off English harbour . . .	8 48	83 51	Cape Hinchinbroke . . .	60 15	146 16
Cape Herradura . . .	9 37	84 21	Cape Elizabeth . . .	59 9	151 28
Cape Blanco . . .	9 28	84 41	Barren Isles . . .	59 00	151 46
Nicoya . . .	9 42	84 57	Point Banks . . .	59 41	152 6
Morro Hermoso . . .	9 45	85 5	Cape Douglas . . .	58 56	152 50
P. St. Catharine . . .	10 29	85 42	Cape Whitunday . . .	58 15	151 46
St. John's Har. . . .	11 22	85 44	Cape Grenville . . .	57 33	152 00
Point Desolado . . .	11 49	86 40	Trinity Islands . . .	56 35	153 40
Leon . . .	12 22	86 46	Foggy Island . . .	56 10	150 45
Realejo . . .	12 27	87 5	Halibut Head Island . . .	54 27	162 30
Averradores . . .	12 35	87 20	Oonahashka Island, N.P. . . .	53 55	166 12
Point Cosignina . . .	12 53	87 37	Bristol R. entrance . . .	58 12	157 33
Point Candadillo . . .	13 7	87 57	Round Island . . .	58 29	159 53
Sacatecoluca . . .	13 26	88 47	Cape Newham . . .	58 34	161 55
Point Remedios . . .	13 30	89 42	Shoalness . . .	60 00	161 52
P. Guimaraes . . .	13 54	90 53	Cape Stephens . . .	63 33	162 17
Puerto Ventosa . . .	16 6	93 22	Cape Denbigh . . .	64 17	161 53
			Cape Rodney . . .	64 34	166 37

TABLE XLVI. Latitudes and Longitudes.

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Cape Prince of Wales	65 45N	169 17W	Richibucto Harbour	46 44N	64 36W
Cape Mulgrave	67 45	165 12	St. John's I. (N. Cape)	47 5	63 45
Cape Lasburne	69 5	165 22	West Point	46 37	64 10
ICY CAPE	70 29	161 42	Cape Egmont	46 28	63 51
V. From the River St. Croix to Cape Cansor.			Halifax Bay	46 25	63 36
	Lat. M. D.	Long. D. M.	East Point	46 27	61 48
Entrance of St. Croix River	45 7N	67 8W	Bear Cape	46 3	62 19
Moccone's I. (entrance of St. John's River)	45 19	66 4	Hillsborough Bay	46 6	62 55
Cape Spencer	45 17	65 52	P. Escuminac	47 3	64 33
C. Chignecto (entrance of Basin of mines)	45 24	64 49	Miscou I. (entrance of Chaleur Bay)	48 3	64 13
Haute Island	45 19	64 51	Cape Despair	48 27	63 48
Annapolis Royal	44 47	65 50	Island Bonaventure	48 32	63 50
Breyer's Island	44 19	65 25	Flat Point	48 39	63 50
St. Mary's Cape	44 10	65 8	Cape Gaspe	48 47	63 52
Cape Fourchu	43 52	66 4	Cape Rozier	48 50	63 54
Seal Isles	43 27	65 55	Magdalen River	49 13	64 49
CAPE SABLE	43 26	65 32	St. Ann's River	49 8	66 8
Sable Island E. point	44 5	60 3	Mount Camille	48 37	67 45
— W ditto	44 3	60 31	I. de Bik in the River St. Lawrence	48 30	68 24
Port Roseway	43 40	65 13	I. of Anticosti, E. P.	49 8	61 40
Port Mansfield	43 50	64 52	— Jupiter's River	49 26	63 25
Gambier Harbour	44 00	64 41	— S. W. ditto	49 22	63 23
LIVERPOOL	44 5	64 40	— West ditto	49 48	64 16
Isle of Hope	43 53	64 39	— North ditto	49 53	63 54
Port Jackson	44 13	64 27	Deadman's Island	47 17	61 58
Charlotte Bay	44 34	63 53	Entry Island	47 15	61 24
C. Sambro light house	44 30	63 32	Amherst Isl. S. W. P.	47 12	61 44
HALIFAX Harbour	44 36	63 28	Magdalen Isl. N. E. P.	47 41	61 5
Port Stephens	45 00	61 59	Biron Island	47 52	61 10
Sandwich Bay	45 8	61 36	Bird Island	47 55	60 46
Torbay	45 12	61 16	St. Paul's Island	47 11	60 4
Port Howe	45 13	61 6	VII. Newfoundland.		
CAPE CANSOR	45 18	60 56		Lat. D. M.	Long. D. M.
VI. The Gulf of St. Lawrence.			Limits of the Great Bank of Newfoundland, N. point	50 15N	49 45W
	Lat. D. M.	Long. D. M.	— South point	41 00	52 00
Chedabucto Bay	45 23N	61 00W	Outer Bank	47 00	45 00
Gut of Cansor, S. ent.	45 28	61 13	Cape Norman	51 42	56 00
Cape Hinchinbroke	45 34	60 40	Seal Islands	51 22	56 50
Cape Portland	45 48	60 3	Point Ferrolle	51 5	57 11
LOUISBURGH	45 54	59 55	St. John's Bay	50 52	57 23
CAPE BRETON	45 57	59 48	Point Riche	50 46	57 28
Seattery Island	46 1	59 41	Ingornechoix Bay	50 39	57 29
Flint Island	46 9	59 49	Bon Bay	49 36	58 5
Spanish Bay	46 18	60 10	Cape St. Gregory	49 22	58 21
Port Dauphin	46 23	60 30	South Head	49 10	58 33
Cape North Island	47 6	60 29	Cape St. George	48 30	59 12
Cheticum Harbour	46 42	60 58	Cape Anguille	48 00	59 19
Sea Wolf Island	46 27	61 12	Cape Ray	47 35	59 15
Port Hood	45 58	61 35	Connor Bay	47 39	58 00
Justan Corp Island	45 56	61 37	Burges Island	47 33	57 37
GUT OF CANSOR, North entrance	45 42	61 27	Rainea Islands	47 32	57 25
Cape St. George or St. Lewis	45 52	61 55	Penguin's Islands	47 24	57 00
Pictou Island	46 51	62 27	Fortune Head	47 9	55 51
Cape Tormentine	46 9	63 35	Burnt Island	47 16	54 51
			Great Miquelon	47 5	56 24
			Langley Island	46 50	56 24
			St. Peter's Island	46 45	56 24

TABLE XLVI. Latitudes and Longitudes.

Greenland.		Lat. D. M.	Long. D. M.	I. Wight.		Lat. D. M.	Long. D. M.
	Bear Sound . . .	63 20N.	49 10W		PORTSMOUTH		
	Maab . . .	68 5	48 27		Town . . .	50 47N.	1 6W
	Cape Farewell . .	59 38	42 42		Isle of Wight . .		
	Whale's Island . .	62 30	13 15		— Cowes . . .	50 46	1 16
	Herjolmsness . . .	65 3	39 50		— Bembridge Ledge or		
Iceland.	Bontokoe Island . .	73 15	7 5	Point . . .	50 41	1 3	
	Gael Hamkes Bay .	75 00	6 51	— Dunnesse . . .	50 37	1 11	
	John Mayen's Island	71 10	9 49	— St. Catharine's Pt.	50 35	1 12	
				— Needle's lights	50 40	1 54	
				Hurst light . . .	50 12	1 25	
				Poole Harboure . .	50 40		
Spitzbergen.		Lat. D. M.	Long. D. M.	South Coast of England.			
	Cape Reikness . . .	63 55N.	22 47W		St. Aldan's Head . .	50 33	
	Bessested . . .	64 6	21 54		Weymouth . . .	50 36	
	Mount Suasell . . .	64 52	23 54		Portland lights . .	0 31	
	Patricford . . .	65 36	24 10		Lymouth Bar . . .	50 38	
	Straumness . . .	65 40	24 29		Forbay, Berry Head	50 42	
	North Cape . . .	66 34	22 10		Dartmouth . . .	50 12	
	Hola . . .	65 44	19 44		Start Point . . .	50 12	
	Grim's Island . . .	66 57	19 12		Frail ditto . . .	50 12	
	Rikeford . . .	66 30	17 35		Bolt Head . . .	12	
	Longnose . . .	66 25	16 19		Eddystone light . .	12	
	Enchuisen Island .	64 20	14 15		Land Dreps . . .	12	
Spitzbergen.	Wreeland ditto . .	63 55	18 19	Ram Head . . .	12		
	Cape Heckla . . .	63 22	19 54				
	Westman's Island .	63 20	20 28	PLYMOUTH			
				Fowey . . .	50		
				Deadman's Point . .	50		
				Falmouth . . .	50		
				Manacles Rocks . .	50 2		
				Black Head . . .	50 1		
				LIZARD Point . . .	49 58	5 11	
				Mount's Bay . . .	50 8	5 30	
				Penzance . . .	50 12	5 33	
				Hunnel's Stone . . .	50 4	5 42	
English Coast from London to St. Mary's Light (Scilly.)		Lat. D. M.	Long. D. M.	North Coast of France.		Lat. D. M.	Long. D. M.
	South Cape . . .	76 32N	13 45E.		CALAIS . . .	50 58N.	1 51E
	Fair Foreland . . .	78 53	8 45		Cape Griz Nez . . .	50 52	1 34
	Amsterdam Isl. (Hack- luyt's Head) . . .	79 46	9 49		Ambleteuse . . .	50 49	1 36
	Smeerenburg Harbour	79 44	9 51		BOLLOGNE . . .	50 44	1 37
	Verlegen Hook . .	80 7	16 50		Etaples . . .	50 31	1 39
	Hope Island . . .	76 30	20 28		Montreuil . . .	50 28	1 45
	Bear or Cherry Island	74 52	14 45		La Rochelle . . .	50 19	1 40
					Abbeville . . .	50 7	1 50
					Grotoy . . .	50 13	1 35
					St. Vallery, R. Somme	50 11	1 36
					Dieppe light . . .	49 56	1 4
Coast of England.		Lat. D. M.	Long. D. M.	Coast of France.		Lat. D. M.	Long. D. M.
	LONDON . . .	51 31N.	0 6W		St. Valley, R. Caux	49 52	0 41
	GREENWICH Obs. . .	51 29	0 00E.		Fecamp . . .	49 46	0 22
	Woolwich . . .	51 30	0 4		Cape de Caux . . .	49 41	0 11
	Furfleet . . .	51 30	0 19		Cape de le Here . .	49 31	0 3
	Gravesend . . .	51 28	0 22		HAVRE DE GRACE .	49 29	0 6
	Rochester . . .	51 23	0 32		PARIS Obs. . .	49 50	2 20
	Sheerness . . .	51 27	0 44		Mouth of Seine . .	49 27	0 3
	Nore . . .	51 28	0 51		Harfleur . . .	49 30	0 11
	N. Foreland light .	51 22	1 27		Honfleur . . .	49 25	0 14
	S. Foreland lights .	51 8	1 22		Caen . . .	49 11	0 21W
	Deal Castle . . .	51 13	1 24		Bayeux . . .	49 16	0 43
Coast of France.	DOVER . . .	51 8	1 19	Carentan . . .	49 18	1 25	
	Dungeness . . .	50 55	0 58				
	Hastings . . .	50 53	0 36				
	Beachy Head . . .	50 44	0 15				
	Brighton . . .	50 50	0 6W				
	Shoreham . . .	50 50	0 16				
	Arundel . . .	50 53	0 35				
	Selsey Bill . . .	50 43	0 48				
	Owers light . . .	50 40	0 40				

261

		Lat.	Long.			Lat.	Long.
	D. M.	D. M.	D. M.		D. M.	D. M.	D. M.
St. Marcou Island	.49 30N.	1 10W		Scarborough	.54 18N	0 10W	
Cape Barfleur Light	.49 42	1 16		Robin Hood's Bay	.54 27	0 20	
CHERBOURGH	.49 38	1 37		Whitby	.54 31	0 26	
Pelee Island	.49 40	1 36		River Tees' Mouth	.54 41	1 2	
Cape la Hogue	.49 45	1 56		Stockton	.54 38	1 8	
Alderney I. N. point	.49 46	2 12		River Tyne's Mouth	.		
Caskets lights	.49 46	2 26		lights	.55 6	1 15	
Guernsey I. W. point	.49 26	2 43		Coquet Island	.55 22	1 21	
Sark I. N. point	.49 26	2 23		Staples light	.55 39	1 40	
Jersey Island	.			Fern light	.55 38	1 42	
— Cape Grosness	.49 18	2 19		Sunderland point	.55 36	1 43	
— St. Aubin	.49 13	2 11		Holy Island	.55 42	1 50	
— St. Clement's point	.49 9	2 00		BERWICK	.55 47	2 3	
I. de Chausey	.48 52	1 50					
Coutances	.49 3	1 27		St. Abb's Head	.55 57	2 6	
Granville	.48 50	1 36		DUNBAR	.56 00	2 29	
Avranches	.48 41	1 22		May Island lights	.56 11	2 32	
Mount St. Michael	.49 38	1 33		The Bass	.56 5	2 36	
Pontorson	.49 33	1 32		N. Berwick	.56 4	2 41	
St. Malo	.48 39	2 1		EDINGBURGH	.55 57	3 12	
Cape Frehel light	.48 41	2 21		Ellyness	.56 11	2 44	
St. Brieux	.49 31	2 42		Fife Ness	.56 17	2 33	
Brehat Island	.48 50	2 56		St. Andrew's	.56 21	2 45	
Tregueir	.48 47	3 15		Mouth of Tay	.56 27	2 39	
Morlaix	.48 35	3 53		Bell Rock, off ditto	.56 27	2 22	
St. Pol de Leon	.48 41	4 00		Buttonness lights	.56 28	2 41	
I. de Bas	.48 46	4 2		Red Head	.56 37	2 24	
Roche Blanche	.49 1	3 58		Montrose	.56 44	2 23	
St. Anthony's lights	.48 40	4 29		Tod Head	.56 51	2 14	
U-HANT, W. point	.48 29	5 3		NEW ABERDEEN	.57 9	2 8	
XV. From the North Foreland to Dun-				Newburgh	.57 20	2 3	
cansbay Head.				Peter Head	.57 32	1 44	
	Lat.	Long.		Buchan Ness	.57 29	1 43	
	D. M.	D. M.		Ratvie Head	.57 38	1 46	
North Foreland	.51 23N.	1 27E.		Kinnaird's Head	.57 42	1 56	
Kentish Knock	.51 41	1 40		Bamff	.57 41	2 27	
Long Sand Head	.51 45	1 38		Fort St. George	.57 38	4 00	
Galloper, N. point	.51 52	2 5		Inverness	.57 32	4 10	
— S. point	.51 41	2 1		Cromatie	.57 43	3 58	
Shipwash, N. point	.52 00	1 36		Tarbet Ness	.57 54	3 44	
— S. point	.51 53	1 33		Clythness	.58 20	3 8	
Gaberd, outer	.51 58	1 59		Noss Head	.58 29	3 6	
Orfordness	.52 5	1 30		Duncansbay Head	.58 40	3 8	
Aldboro' Knaps	.52 7	1 40		XVI. The Orkney Islands.			
Southwold	.52 20	1 39			Lat.	Long.	
Leostoff lights	.52 29	1 46			D. M.	D. M.	
Yarmouth	.52 37	1 44		Pentland Skerries	.58 43N	3 3W	
Winterton Neas lights	.52 43	1 43		Stromo	.58 43	3 14	
Smith's Knowl	.52 54	2 20		South Ronaldsha, S. P.	.58 44	3 5	
Hasborough Sand, S. P.	.52 51	1 48		Copinsha	.58 54	2 47	
— N. P.	.53 2	1 35		Lam's Head on Stromsa			
Sherringham Shoals	.53 3	1 20		Island	.59 4	2 40	
Hasborough lights	.52 49	1 34		North Ronaldsha, N. P.	.59 23	2 31	
Cromer lights	.52 56	1 26		Mould Head, on Papa			
Lemon and Ower, N. P.	.53 14	1 58		Westra Island	.59 21	3 2	
— S. P.	.53 8	2 00		Noup Head, on Westra			
Cromer Bank	.53 11	1 35		Island	.59 18	3 14	
Dudgeon light	.53 15	1 9		Marwick Head, on Po-			
Outer Dowsing	.53 33	1 14		mona Island	.59 6	3 28	
Inner Dowsing	.53 15	0 44		Stromness	.58 57	3 26	
Lynn Knock	.53 3	0 29		Hoy Head, on Hoy			
Spurn lights	.53 38	0 20		Wells Island	.58 55	3 31	

TABLE XLVI. Latitudes and Longitudes.

Shetland I.
Ferro I.

N. and W. Coast of Scotland.

West Coast of England.

West Coast of Ireland.

XVII. The Shetland Islands.			Lat.		Long.	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
Sunbro Head, S. point.	59 49N.	1 30W				
Rose or Hangcliff	60 13	0 40				
Brassa Sound, Lerwick	60 11	1 00				
Out Skerries	60 37	0 8				
Whalsey Isle	60 32	0 32				
Uist Island, N. E. P.	61 7	0 15				
Foul Island	60 8	2 16				
XVIII. Ferro Islands.			Lat.		Long.	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
The Monk Rock appears like a ship under sail	61 15N	6 47W				
Fucos I. (N. E. part of Ferro)	62 15	6 2				
East point of Mygenes Island, N. W. part of Ferro Islands	62 3	7 32				
XIX. From Duncansbay Head to the Land's End			Lat.		Long.	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
Duncansbay Head	58 40N	3 8W				
Dunnet Head	58 43	3 29				
Farout Head	58 38	5 00				
Cape Wrath, or Barre Head	58 36	5 20				
A Rock seen at $\frac{1}{2}$ Ebb	58 45	5 21				
Rona Island	58 55	6 15				
Rockal	57 49	14 6				
St. Kilda	57 51	8 56				
Butt of the Lewis	58 29	6 34				
Gallen Head	58 10	7 10				
Flannan Islands	58 13	7 30				
Hyskere Island	57 23	7 38				
South Uist Island	57 9	7 10				
Mingalay Island	56 49	7 33				
Rea Head	57 50	5 44				
Cana Islands	57 3	6 38				
Helsker Island	56 56	6 39				
Rum I. W. P.	56 59	6 26				
Tirey Island, S. P.	56 30	6 52				
Goll I. North P.	56 42	6 25				
Skerryvore	56 17	7 2				
Ilia Island, S. W. P.	55 47	6 24				
— South P.	55 39	6 10				
Mull of Cantire light house	55 20	5 37				
I. of Arran, S. E. part	55 31	4 57				
Cumray I. entrance of Clyde	55 47	4 48				
GLASGOW	55 52	4 16				
Elsa Island	55 20	4 55				
Irwin	55 39	4 30				
Air Light	55 26	4 28				
Loch Ryan	55 3	5 00				
Port Patrick Light	54 48	4 58				
Mull of Galloway	54 37	4 45				
Great Scar Island	54 40	4 36				
Burrow Head	54 41	4 16				
			Lat.		Long.	
			D. M.	D. M.	D. M.	D. M.
Solway Firth			54 47N.	3 20W		
CARLISLE			54 54	2 44		
St. Bee's Head Light			54 30	3 30		
White Haven			54 32	3 22		
Belker Rock			54 16	3 19		
Lancaster			54 2	2 41		
Formby Point			53 32	2 68		
LIVERPOOL			53 22	2 62		
Point of Air Light			53 20	3 11		
Great Orms Head			53 20	3 43		
Point Linas Light			53 24	4 11		
Skerries Light			53 24	4 30		
Holyhead, W. P.			53 18	4 32		
Branchy Pool Head			52 47	4 37		
Bardsey Island			52 44	4 38		
Barmouth			52 43	3 52		
Aberiswith			52 23	3 53		
Cardigan Harbour			52 6	4 32		
Strumble Head			52 1	5 10		
St. David's Head			51 55	5 20		
Ramsay Island			51 52	5 22		
Small's light house			51 45	5 36		
St. Ann's ditto, Milford Haven			51 41	5 10		
St. Gowan's Head			51 35	4 59		
Caldy Island			51 40	4 40		
Worm's Head			51 34	4 17		
Mumble's Point & light			51 34	3 57		
Nash Point			51 26	3 33		
BRISTOL			51 27	2 33		
Flatholm light			51 23	3 6		
Lundy Island, entrance of Bristol Channel			51 10	4 38		
Most P. entrance of Bristol Channel			51 11	4 12		
Hartland Point			51 1	4 20		
Padstow			50 35	4 54		
Cow and Calf			50 33	5 6		
Towan Head			50 25	5 9		
St. Ives Bay			50 13	5 23		
Cape Cornwall			50 8	5 41		
The Seven Stones			50 2	6 6		
The Wolf Rock			49 53	5 51		
The Land's End			50 4	5 42		
XX. Ireland.			Lat.		Long.	
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
CAPE CLEAR	51 22N.	9 30W				
Fastnet Rock	51 19	9 44				
Crook Haven	51 26	9 52				
Mizen Head	51 25	10 1				
Sheep's Head	51 33	10 5				
Bantry Bay	51 36	10 10				
Greagh Rocks	51 31	10 30				
Dursey I. W. P.	51 37	10 36				
Bull Rock	51 38	10 42				
Cow ditto	51 37	10 39				
Cod's Head	51 42	10 27				
Keamare Bay	51 44	10 30				
Lamb's Head	51 47	10 28				
Hog Islands	51 49	10 38				
Log's Head	51 50	10 35				
Bolus Head	51 52	10 42				

TABLE XLVI. Latitudes and Longitudes.

265

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
West Coast of Ireland.	Skelling's Rocks .	51 52N	11 00W		E. C. of Ireland.	St. Patrick's Island .	53 36N	6 2W	
	Lemon Rock .	51 53	10 53			Lambay Island .	53 29	5 59	
	Bray Head .	51 58	10 50			Hawth Head light .	53 22	6 2	
	Dingle Bay .	52 5	10 50			DUBLIN .	53 22	6 17	
	Loze Rock .	52 6	11 6			WICKLOW lights .	52 59	6 1	
	Ferriter's Island .	52 8	11 1			Arklow .	52 49	6 6	
	Tiraght Rocks .	52 10	11 4			Glasseyrick .	52 36	6 11	
	Great Blasket .	52 11	10 59			—			
	Ennis Tuscan .	52 14	11 00			WEXFORD .	52 21	6 28	
	Dunmore Head .	52 12	10 53			Tusker Rock .	52 12	6 8	
	Dunorling Head .	52 19	10 49			Carnsore Point .	52 11	6 19	
	Brandon Head .	52 23	10 36			The Saltees Rocks .	52 6	6 11	
	The Seven Hogs Rocks	52 26	10 31			Hook light, Waterford			
	Kerry Head, S. entrance					harbour .	52 5	6 56	
	of Shannon River .	52 30	10 24			Dungarven .	52 3	7 36	
	Loop Head, N. entrance					Helwick Head .	51 55	7 31	
	ditto .	52 37	10 23			Loughall .	51 55	7 49	
	LIMERICK .	52 42	9 12			CORK Harbour .	51 47	8 11	
	Clare .	52 51	9 32			Kingsale Harbour .	51 38	8 29	
	Hag's Head .	53 5	9 43			Old Head of Kingsale			
	North Arran or Killaney	53 18	10 4			lights .	51 38	9 30	
North Coast of Ireland.	Galway Bay .	53 17	9 49		South Coast of Ireland.	Seven Heads .	51 34	8 40	
	Shine Head .	53 35	10 32			Dundedy Head .	51 32	8 56	
	Ennis Shark I. .	53 46	10 36			The Stags, off Toe head	51 27	9 16	
	Ennis Turk I. .	53 52	10 21			BALTIMORE harbour	51 27	9 26	
	Clare Island .	53 58	10 14						
	Achul Head .	54 7	10 30						
	Black Rock .	54 13	10 36						
	Lorris Head .	54 28	10 18						
	Broad Haven .	54 26	10 12						
	Tuna Rocks, off Broad								
	Haven .	54 31	10 4						
	Down Patrick Head	54 27	9 36						
	Killala .	54 19	9 27						
	Sligo Bay .	54 24	8 59						
	Ennis Murray Island	54 32	8 57						
	Donnegal Bay .	54 38	8 50						
	Tillen Head .	54 42	8 59						
	Arranmore .	55 2	8 38						
	Bloody Foreland .	55 10	8 16						
	Tory Island .	55 17	8 16						
East Coast of Ireland.	Hoar Head .	55 14	7 57		N. of France.				
	Mulroy .	55 17	7 48						
	Loch Swilley .	55 18	7 33						
	Mallin Head .	55 24	7 24						
	Ennistrahul Rocks light	55 29	7 14						
	Inishone Head, entrance								
	of Londonderry .	55 16	6 54						
	LONDONDERRY .	55 00	7 15						
	Giant's Causeway .	55 16	6 26						
	Racklin I. W. point	55 20	6 16						
	Fair Head .	55 15	6 6						
	Torr Point .	55 14	6 1						
	The Maid's Rocks .	54 57	5 39						
	Black Head .	54 45	5 38						
	Carrickfergus .	54 43	5 46						
	BELFAST .	54 35	5 57						
	Belfast Loch .	54 43	5 35						
	Mew Island lights .	54 41	5 24						
	South Rock light .	54 21	5 24						
East Coast of Ireland.	Dundrum .	54 13	5 51		Holland.				
	Carlingford Lock .	54 00	6 4						
	Dundalk .	53 59	6 20						
	Drogheda Bay .	53 48	6 14						

XXI. The Isle of Man.

	Lat.	Long.
D. M.	D. M.	D. M.
Calf of Man .	54 2N	4 42W
Douglase .	54 9	4 24
Ramsey Bay .	54 19	4 16
Point of Air .	54 22	4 18
Peel Hill .	54 12	4 37
Castletown .	54 3	4 55

XXII. From Calais to the Seine.

	Lat.	Long.
D. M.	D. M.	D. M.
CALAIS .	50 58N	1 51E.
Gravelines .	50 59	2 8
DUNKIRK .	51 2	2 22
Nieuport .	51 8	2 45
OSTEND .	51 14	2 55
Sluys .	51 19	3 23
ANTWERP .	51 13	4 24
Walcheren I. W. P. .	51 32	3 28
— Flushing .	51 27	3 35
— Middleburgh .	51 30	3 37
Goeree Island .	51 46	3 52
Schouwen Island light	51 39	3 40
North Gatt .	51 55	3 59
Holland's Hook .	51 56	4 00
The Hague .	52 4	4 16
Leyden .	52 9	4 26
Maarssen .	52 22	4 36
ROTTERDAM .	51 54	4 22
AMSTERDAM .	52 22	4 51
Alkmaar .	52 39	4 39
Taxel S. point .	53 2	4 33
Harlingen .	53 10	5 20
Gottingen. Obs. .	51 32	9 53
EMBDEN .	53 20	7 10
BREMEN .	52 6	8 26

TABLE XLVI. Latitudes and Longitudes.

225

Islands of the Baltic.		Lat.	Long.	Norway.		Lat.	Long.
		D. M.	D. M.			D. M.	D. M.
	Gotland, N. E. end	57 51N	19 28E		Great Wylingose light	59 4N	6 55E
	— WISBY	57 39	18 20		house		5 45
	— Hoburg	56 57	15 12		Stavanger		5 00
	Great Carlsö	57 19	18 00		Bommel Island, S. end	59 32	5 12
	Oland, N. end	57 22	17 7		BERGEN	60 24	5 12
	— Borgholms Slott	56 52	16 37		Akwold	61 22	5 12
	— S. end light	56 12	16 26		Ronde light		5 41
	Eartholms	55 19	15 16		Christian Sound	63 11	7 30
	Bornholm, N. W. end			Drontheim	63 26	10 22	
	— light	53 18	14 49	Werro Island	67 42	31 25	
	— Hasle	56 10	14 47	NORTH CAPE	71 10	26 00	
	— S. E. end	54 58	15 14	Wardhus Island	70 22	31 6	
	— Svanike	55 3	15 16	River Kola	69 15	33 24	
	Rügen, N. end	54 40	13 30	Nagel Island	68 23	38 55	
	— BERGEN	54 25	13 38	Cape Sweetness	67 58	37 30	
	— S. E. end New			Cape Orlogensö	67 00	39 21	
	Deep	54 16		Cross Island	66 19	38 49	
				Owaga	63 36	37 20	
XXV. Gulfs of Finland and Bothnia.				White Sea.	Cape Donega	64 46	35 46
	Lat.	Long.	ARCHANGEL		64 34	38 59	
	D. M.	D. M.	Blissness		65 21		
Odensholm light	59 19N	23 18E	Cape Good Fortune		66 24	40 28	
Great Roge light	59 25	24 3	Mershom Island				
Sutep Head light	59 28		Cape Candiness		68 23	41 20	
Nargen I. N. point	59 36	24 34	Welgate's Straits				
REVEL	59 26	24 48	Nova Zembla		78 00	70 00	
Kokskar light	59 40	25 6					
Chalk Ground	59 41	26 15					
Islands of the Baltic.	Stone Skar	59 46	26 30	XXVIII. From Ushant to Gibraltar.			
	Little Titters Island	59 47	27 3		Lat.	Long.	
	Great Titters Island	59 50	27 20		D. M.	D. M.	
	Lavanscar, N. end	59 59		USHANT	48 29N	5 3W	
	Seascar light	59 59	28 28	BREST	48 23	4 29	
	Narva	59 20	28 24	Saint Matthew's light	48 19	4 47	
	Dolgenos	59 53	29 6	Point Raz	48 1	4 47	
	Tolbocon light	60 00	29 39	Saints Rocks	48 4	5 5	
	CRONSTADT	59 58	29 53	Point L'Abbe	47 49	4 12	
	PETERSBURG	59 56	30 19	Quimper	47 58	4 8	
	Styr's Udden	60 8	30 10	Iles de Glénan	47 44	4 00	
	Wiburg	60 39	30 54	Quimperlay	47 59	3 34	
	Fredericksburg	60 30	27 25	L'ORIENT	47 45	3 21	
	Aspo	60 14	27 22	Port Louis	47 43	3 21	
	Hogland Island lights	60 3	27 7	Ile de Groix	47 38	3 23	
	Orregrund's Beacon	60 14	26 39	Quiberon, S. point	47 26	3 4	
	Lovisa	60 25	26 29	Belle Isle, N. end	47 23	3 14	
	Borgo	60 21	25 50	— S. end	47 17	3 5	
	Helmsfore	60 10	25 7	Vannes	47 39	2 46	
	Hango Beacon	59 45	22 57	Houat Isle	47 24	2 56	
	XXVI. Gulf of Bothnia.				Dumet Isle		2 36
		Lat.	Long.	NANTES	47 13	1 33	
		D. M.	D. M.	Croix	47 18	2 31	
	Uto light	59 47N	21 25E	St. Gildas point	47 10	2 16	
	Åbo	60 27	22 15	Noirmoustier I. S. W.	47 00	2 15	
	Vasa	63 13	21 55	Dien Isle	46 42	2 27	
	TORNEA	65 51	24 9	St. Gilles	46 40	1 51	
XXVII. From the Naaz to Archangel.				Roche Bon	46 15	2 24	
	Lat.	Long.	Ree Isle Light	46 15	1 34		
	D. M.	D. M.	ROCHELLE	46 9	1 9		
The NAZE		7 14E	ROCHEFORT	45 56	0 58		
Lister Land	58 10	6 28	Oleron Isle light	46 3	1 24		
Judder, or Wolfert's Id.	58 26	5 48	Island Aix	46 1	1 10		
			CORDOVAN light H.	45 35	1 10		
			Medoc	45 6	0 45		
			BORDEAUX	44 50	0 34		
			Cape Feret	44 43	1 14		
			BAYONNE	43 29	1 29		

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
North Coast of Spain.	St. John de Luz	43 23N.	1 39W		Bay of Roses	42 15N.	3 7E		
	St. Sebastian	43 21	1 57		Cape de Greux	42 20	3 17		
	Cape Machicao	43 28	2 40		Perpignan	42 42	2 54		
	BILBOA	43 15	2 44		Agde	43 19	3 28		
	SAINT ANDERO	43 28	3 40		Fort Brecon	43 15	3 29		
	Saint Vincent	43 30	4 16		Cette light	43 24	3 42		
	Villa Viciosa	43 28	5 18		Narbonne	43 11	3 00		
	Cape Penas	43 42	5 46		Montpellier	43 37	3 52		
	Cape Burola	43 42	7 17		MARSEILLES	43 18	5 22		
	Cape Vanas	43 47	7 35		Ciotta	43 10	5 36		
	Cape Ortegal	43 47	7 48		TOULON	43 7	5 55		
	Cape Prior	43 34	8 14		Cape Taillar	43 7	6 44		
	FERROL	43 30	8 6		St. Tropez	43 16	6 40		
	CORUNNA	43 23	8 20		Frejus	43 26	6 44		
	Cape Belem	43 10	9 10		Cape Roux	43 22	7 00		
	Cape Turiana	43 3	9 17		Antibes	43 35	7 7		
	Cape Finistere	42 54	9 17		St. Marguerite Island	43 31	7 3		
	Vigo Bay	42 14	8 37		Cape de Oropes	43 28	7 10		
	Cape Fasalis	41 59	8 45		Nice	43 42	7 17		
	OPORTO	41 11	8 38		Villa Franca	43 40	7 20		
Portugal.	Averios	40 39	8 41		Cape Melle	43 56	8 8		
	Coimbre	40 14	8 24		Savona	44 17	8 30		
	Cape Mondego	40 12	8 54		GENOA	44 25	8 56		
	Cape Fisseraon	39 24	9 18		Rapallo	44 23	9 16		
	The Burlings	39 25	9 31		Point Venere	44 3	9 45		
	The Rock of Lisbon	38 46	9 29		LEGHORN	43 33	10 22		
	LISBON	38 42	9 9		Maloria	43 33	10 17		
	Cape Epichel	38 25	9 14		Cape M. Nero	43 25	10 20		
	St. Ubes	38 32	8 50		Vada	43 20	10 41		
	Sines	37 50	8 54		Piombino	42 56	10 35		
	Cape St. Vincent	37 3	9 2		Point Hercole	42 23	11 10		
	Lagos	37 8	8 39		Civita Vecchia	42 5	11 46		
	Cape Carbonera	37 7	8 19		ROME	41 54	12 28		
	Cape St. Mary	36 57	7 52		Cape Dazia	41 26	12 40		
	Point Arenilla	37 8	6 50		Cercello Point	41 9	13 00		
	St. Lucar	36 46	6 20		Gaeta	41 15	13 38		
	SEVILLE	36 59	5 58		NAPLES	40 51	14 11		
	CADIZ	36 32	6 18		Salerno	40 42	14 46		
	Cape Trafalgar	36 10	6 00		Cape Licosa	40 18	14 57		
	Tarifa Island	36 1	5 35		PolICASTRO	40 7	15 43		
South Coast of Spain.	P. Carnero	36 5	5 23		St. Eufemia	39 00	16 42		
	Algesiras	36 7	5 24		Cape Batican	38 47	16 25		
	GIBRALTAR	36 6	5 20		Cape Grose	38 20	16 10		
					Cape Larme	37 56	16 15		
					S. Point of Italy	37 53			
					Cape Spartavento	37 57	16 22		
					Cape Stillo	38 26	16 55		
					Catanzaro	39 1	16 55		
					Cape Rizuta	39 54	17 31		
					Cape Callone light	39 4	17 36		
					Taranto	40 28	17 35		
					Galipoli	40 00	18 20		
					Cape St. Mary, the entrance to the Gulf of Venice	39 50	18 50		
					Otranto	40 19	19 55		
					Brindisi	40 38	18 12		
					Bari	41 9	17 00		
					Manfredonia	41 40	16 8		
					Ortona	42 20	14 30		
					Ancona	43 38	13 30		
					Ramino	44 4	12 33		
South Coast of Italy.					VENICE	45 26	12 21		
					TRIESTE	45 46	13 47		
					Rovigno	45 9	13 48		
					St. Maria	45 30	14 18		

XXIX. The North Coast of the Mediterranean Sea, from Gibraltar to Constantinople.

	Lat.		Long.	
	D.	M.	D.	M.
GIBRALTAR	36	6N.	5	20W
MALAGA	36	43	4	24
Modril	36	45	3	33
Almeria	36	51	2	31
Cape de Gatt	36	44	2	13
Point Calla	36	47	2	00
CARTHAGENA	37	36	1	1
Cape Pallos	37	37	0	41
ALICANT	38	18	0	29
Cape St. Martin	38	47	0	10E.
VALENCIA	39	26	0	20W
Cape Oropeso	40	6	0	8E.
River Ebro	40	42	0	27
Terragona	41	9	1	19
BARCELONA	41	22	2	12
Cape St. Sebastian	41	53	3	9

TABLE XLVI. Latitudes and Longitudes.

207

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Gulf of Venice.	45	14N	14	58E.	Cape Ferrat	36	2N	0	10W
	44	45	15	40	Cape Tennis	36	38	1	16E.
	44	17	15	35	ALGIERS	36	49	2	13
	43	42	16	10	Cape Matifor	36	55	2	43
	43	2	17	10	Cape Beringa	36	53	3	30
	42	40	19	11	Cape Tanels	36	59	4	10
	42	23	19	29	Cape Bugaroni	36	50	5	47
	41	30	20	00	Cape Ferro	36	52	6	54
	41	20	19	46	Bona	36	32	7	36
	40	45	20	16	Tabarca	36	48	8	58
	40	32	19	55	Cape Serra	37	10	9	24
	39	47	20	33	Cape Blanco	37	20	9	53
	39	24	20	36	TUNIS	36	32	10	34
	38	16	22	4	Cape Bon	37	5	11	8
	36	46	21	50	Susa	35	45	10	50
	36	23	22	30	Cape Paul	35	14	11	15
	36	27	23	12	Cape de Zoara	33	53	11	10
	37	53	23	2	Ichy	33	12	11	24
	37	58	23	46	TRIPOLI	32	54	13	11
	38	27	23	44	Lebida	32	8	14	55
	38	9	24	40	Cape Mensurato	32	12	16	15
	39	25	23	17	Cape Lorat	30	50	17	22
Turkey in Europe					Cape Linconta	30	29	19	20
					Cape Serabion	31	21	20	16
					Zoara	30	44	20	45
					Bengaza	32	16	20	20
					Cape Docra	32	55	21	26
					DERNE	32	48	22	11
					Cape Razatin	32	30	23	5
					Cape Luco	31	50	25	00
					Cape Soliman	31	44	25	18
					Point Ramadan	31	32	26	00
					Cape Lagooego	31	23	27	20
					Cape Capopera	31	13	28	44
					Cape Rose	31	8	29	30
					ALEXANDRIA	31	13	30	16
					Aboukir	31	18	30	38
Black Sea.					Rosetta	31	24	30	58
					Cape Bourlos	31	33	31	30
					Demiatta	31	24	32	7
					Cape Callo	31	20	33	30
					El Arish	31	13	33	50
					Jaffa	32	6	35	3
					M. Carmel	32	50	35	16
					Acro	32	00	35	26
					Cape Blanco	33	10	35	19
					Cape Serpente	33	28	35	35
Coast of Barbary.					Cape Vardo	34	11	35	50
					Tripoly	34	46	36	7
					Tortosa	35	22	36	8
					Cape Zaret	36	14	35	53
					ALEXANDRETTA, or				
					Scanderoon	36	35	36	20
					Yasso	36	58	36	16
					ALEPPO	36	11	37	10
					Cape Orco	36	40	34	12
					Point Calvero	36	34	33	25
Coast of Barbary.					Cape Draumonts	36	30	32	20
					Satalia	37	3	30	55
					Cape Chelidoni	36	18	30	40
					Rosso Island	36	8	29	59
					Cape Seven capes	36	26	29	00
					Macri	36	40	29	30
					Cape Baiho	36	38	27	4.
					Cape Crio	36	45	27	15
					Cape St. Mary	37	39	27	7

XXX. The Black Sea and Sea of Azof.

	Lat.		Long.	
	D.	M.	D.	M.
Ismaïl	45	21N	28	50E.
Akerman	46	11	30	16
Idessa	46	28	30	37
Kherson	46	39	32	56
Koslof	45	15	33	25
Sevastopol	44	40	33	36
Yenicalé	45	22	36	27
Panagoria	45	12	36	30
Peganyoy	47	12	36	39
Trebizonde	41	2	39	37
Cape Yassoun	41	10	37	48
Sinope	42	3	35	9

XXXI. The South Coast of the Mediterranean Sea.

	Lat.		Long.	
	D.	M.	D.	M.
Cape Spartal	35	49N	5	54W
TANGIER	35	40	5	49
Couta	35	54	5	16
Cetuan	35	19	5	27
Cape Negril	36	14	4	24
Cape Baialal	35	10	3	44
Cape Thron Forcas	35	23	2	57
Zaffarng	34	57	2	8
Cape Fegalla	35	47	1	9
Cape Fegala	35	58	0	48

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Turkey in Asia.									
Cape Black . . .	38	46N	26	25E.	Capra . . .	40	31N	14	18E.
SMYRNA . . .	38	28	27	20	MESSINA . . .	38	14	15	49
Adramitta . . .	39	37	27	5	Cape Orlando . . .	38	20	14	40
Cape Baba . . .	39	35	26	10	Cape Cefala . . .	38	15	14	5
Cape Janesari . . .	40	3	26	24	Cape Cafrana . . .	38	18	13	36
Mondania . . .	40	26	28	50	PALERMO . . .	38	7	13	20
Scutari . . .	40	57	29	4	Cape Alos . . .	38	18	13	23
XXXII. Islands within the Straits.					Cape St. Visto . . .	38	17	12	50
					Tripiano . . .	38	9	12	56
					Cape Ruxo . . .	37	17	13	20
					Cape Alicata . . .	37	3	13	50
					Cape Secha . . .	36	49	14	26
					Cape Passari . . .	36	41	15	36
					Saragossa . . .	37	5	15	30
					Cape Carmale . . .	37	24	15	39
					Cape Moline . . .	37	37	15	43
					Stromboli . . .	38	56	15	44
					Lipari, S. point . . .	38	37	15	7
					Salina . . .	38	44	14	55
					Volcano . . .	38	32	15	7
					Felicudi . . .	38	35	14	27
					Alicudi . . .	38	36	14	12
					Ustica . . .	38	51	13	20
					Levaci . . .	38	5	12	25
					Maretime . . .	38	1	12	5
					Favognana . . .	37	56	12	23
					Quill Rocks . . .	37	35	11	15
					Pantellaria . . .	36	45	12	31
					Linosa . . .	35	52	12	55
					La Pidossa . . .	35	31	12	47
					Lampion . . .	35	30	12	30
					Gozo, N. point . . .	36	3	14	5
					C. Comoneto . . .	35	54	14	11
					La Valette . . .	35	54	14	29
					Cape Nicholas . . .	35	47	14	39
					Fano, entrance to the				
					gulf of Venice . . .	40	5	19	32
					Pelagosa . . .	42	23	16	20
					Plana . . .	42	20	16	3
					Tremiti . . .	42	19	15	40
					Lissa, S. point . . .	42	57	16	15
					Pomo . . .	43	13	15	46
					Longa, S. E. point . . .	44	1	15	43
					Corfu, S. E. point . . .	39	47	20	1
					Paxu, S. point . . .	39	24	20	22
					St. Maura, W. point . . .	38	54	20	41
					Cefalonia, S. point . . .	38	7	20	53
					— Cape Viscardo . . .	38	30	20	47
					Zante, S. point . . .	37	50	20	49
					Cerigo, S. Point . . .	36	20	23	1
					Cerrigotto . . .	35	54	23	24
					Milo, Town . . .	36	41	24	50
					Scio, Town . . .	38	30	26	3
					Mytelene, Town . . .	39	12	26	27
					Tenedos . . .	39	50	26	6
					Lemnos . . .	39	54	26	28
					C. Crio . . .	35	12	23	39
					Cape Spada . . .	35	47	23	57
					Suda . . .	35	30	24	24
					Cape Sasso . . .	35	35	25	7
					CANDIA . . .	35	19	25	18
Majorca.									
MAJORCA, S. point	39	20	2	42					
— N. ditto . . .	40	7	3	00					
— W. ditto . . .	39	45	2	7					
— E. ditto . . .	39	42	3	17					
— MAJORCA TOWN	39	34	2	39					
Dragon Island . . .	39	49	1	59					
Colebres . . .	39	52	0	30					
Minorca, S. point	39	43	3	42					
— PORT MAHON	39	52	4	22					
— N. point . . .	40	18	3	35					
Cape Corse . . .	43	2	9	19					
Saint Florenzo . . .	42	35	9	16					
Calvi . . .	42	30	8	40					
Ajacio . . .	41	52	8	44					
South point . . .	41	21	9	21					
Cape Signo . . .	42	14	9	37					
BASTIA . . .	42	27	9	32					
N. P. Lagosardo . . .	41	14	9	2					
Cape Asinara . . .	40	53	8	6					
Cape Caccia . . .	40	31	8	7					
Cape Otano . . .	39	9	8	14					
Cape Malfetena . . .	38	50	8	54					
CAGLIARI . . .	39	15	9	30					
Cape Carbonera . . .	38	57	9	48					
Cape Frances . . .	39	39	9	50					
Olastra . . .	40	8	9	34					
Cape Cavallo . . .	40	48	9	47					
Asinara Isl. N. point	41	7	8	14					
Antioch Island . . .	38	55	8	15					
Toro . . .	38	47	8	18					
Galita Island . . .	37	38	9	3					
Gorgona . . .	43	25	9	51					
Cabrera . . .	43	8	9	50					
Elba . . .	42	50	10	12					
Planera . . .	42	43	10	7					
Formigues . . .	42	33	10	5					
Monte Christo . . .	42	17	10	26					
Gilio . . .	42	22	11	00					
Ganuto . . .	42	16	11	10					
Palmaria . . .	40	43	13	00					
Isola . . .	40	42	13	6					
Ischia, S. point . . .	40	38	13	56					

TABLE XLVI. Latitudes and Longitudes.

299

		Lat.		Long.	
		D.	M.	D.	M.
Canada.	Cape Sidra	35	29N	26	28E
	Cape Salamone	35	00	26	20
	Goza	34	50	24	1
	Goza, S. point	35	24	27	9
	Seapanto	35	37	27	7
Cyprus.	Rhodes, Town	36	27	28	30
	Rhodes, Cape St. Gioane	35	57	28	21
	Cape Andrew	35	41	24	39
	Charma	35	19	32	47
	Cape Salizani	35	3	31	41
Teneriffe.	Cape Gatto	34	34	33	8
	Cape Greco	35	7	34	5
	XXXIII. The Coast of Africa from Cape Spartel to Cape Verd.				
		Lat.		Long.	
		D.	M.	D.	M.
Morocco.	Cape Spartel	35	49N	5	54W
	Larnab	35	11	6	12
	New Salloo	34	5	6	43
	Mazagan	33	18	8	25
	Cape Blanco	33	9	8	40
	Cape Cantin	33	25	9	5
	Safia Bay	33	20	8	46
	MOGADORE Island	31	25	9	31
	Cape Geer	30	33	9	52
	Cleveland's Shoal	30	45	10	31
	Santa Cruz	30	30	9	38
	Cape Nun	28	37	11	15
	Entrance of R. Nun	28	17	11	31
	Cape Blanca	27	54		
	Cape Bajador	26	12	14	27
	Cape Das Barbas	22	15	16	40
	Cape Blanco	20	55	17	10
	Cape St. Ann	20	33	16	38
	Cape Myric	19	10	16	30
	Senegal.	Portendic	18	7	16	3
SENEGAL, P. Broberie		15	53	16	31
St. Anthony.	CAPE VERD	14	47	17	33
	XXXIV. The Western Islands.				
		Lat.		Long.	
		D.	M.	D.	M.
St. Anthony.	Corvo	39	44N	31	7W
	Floris	39	26	31	7
	Fayal, S. E. point	38	30	28	42
	Pico, Point de Espertal	38	26	28	35
	— Summit of Peak	38	27	28	23
	St. George, S. E. point	38	31	27	50
	Graciosa, Villa da Praya	39	2	27	40
	Terceira, Angra	38	39	27	12
	St. Michael, P. Delegada	37	45	25	39
	— Point Ferraria	37	54	25	58
	— N. E. Point	37	49	25	15
	Formigas or Ants	37	17	24	54
	St. Mary, Town	36	59	25	10
	— West Point	36	59	25	14
	XXXV. Madeira Islands.				
		Lat.		Long.	
		D.	M.	D.	M.
St. Anthony.	Porto Santa, Town	33	4N	16	14W
	Madeira, Lencoso pt.	32	42	16	35

		Lat.		Long.	
		D.	M.	D.	M.
Madeira.	Madeira, Tristram point	32	54N.	17	14W
	— FUNOHAL	33	38	16	54
	S. Desertos, S. point	32	22	15	31
	Isl. Salvages, middle	30	13	15	42
	Piton	30	5	15	54
XXXVI. Canary Islands.					
		Lat.		Long.	
		D.	M.	D.	M.
St. Anthony.	Palma, Town	28	39N.	17	50W
	— N. point	28	50	18	00
	— S. point	28	31	17	56
	Ferro, Valverde	27	47	17	55
	Gomero, St. Sebastian	28	6	17	8
	Teneriffe, Hidalgo point	28	40	16	21
	— Orotava	28	34	16	25
	— Tena Point	28	17	17	1
	— Peak	28	16	16	46
	— Port Christianos	27	57	16	52
	— SANTA CRUZ	28	27	16	15
	Canary, N. E. point				
	— Palmas	29	8	15	43
	— S. W. point	27	45	16	3
	Puertoventura				
	— Point Gorda	29	46	13	59
	— S. W. point	28	4	14	31
	Lanzarote, S. point	28	51	13	35
	— Puerto de Naos	28	57	13	23
	Punta del Farion	29	14	13	12
Graciosa	29	14	13	14	
St. Claire	29	17	13	13	
Alegreza	29	20	13	10	
XXXVII. Cape Verde Islands.					
		Lat.		Long.	
		D.	M.	D.	M.
St. Anthony.	St. Anthony, N. W. P.	17	12N.	25	19W
	— N. E. point	17	8	25	8
	— SANTA CRUZ	17	2	25	15
	St. Vincent	16	59	25	6
	St. Lucia	16	45	24	55
	St. Nicholas, N. point	16	46	24	37
	— East point	16	28	24	12
	Salt Island	16	45	23	56
	Bonavista	16	4	23	45
	Laton Rock	15	49	23	14
	Isle of May	15	6	23	8
	St. Jago				
	— PORTO PRAYA	14	54	23	30
	— N. W. point	15	26	23	48
	Pogo, N. point	14	57	24	22
— Middle	14	52	24	23	
Brava, S. point			24	43	
XXXVIII. From Cape Verd to the Cape of Good Hope.					
		Lat.		Long.	
		D.	M.	D.	M.
St. Anthony.	CAPE VERD	14	49N.	17	33W
	Goree Isle	14	40	17	26
	Cape Naze			17	12
	Cape St. Mary, ent. to the River Gambia	13	19	16	40
	Cape Roxo	13	12	16	48
Cape Vera	20	5	16	25	

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Guinea.	Delos Isles	9 22N.	13 26W		St. Th's. M. of W. B. S. P.	0 5N.	6 35E		
	CAPE SIERRA LEON	8 29	13 3		Annabona	1 32 S.	5 45		
	St. Ann's Shoal, W. P.	7 5	13 28		Trinidad	20 23	29 5W		
	Cape Ann	7 6	12 21		Martin Vas, (largest)	20 31	28 33		
	Cape Mount	6 46	11 10		ASCENSION	7 56	14 16		
	Cape Mesurada	6 21	10 40		ST. HELENA, James				
	Sestos River	5 34	9 13		Town	15 55	5 36		
	Cape Palmas	4 30	7 41		Saxemburgh*	30 22	24 00		
	St. Andrew's River	5 00	6 10		Tristan d'Acunha, N. P.	37 7	11 49		
	Cape Lahon	5 15	5 17		Inaccessible Island	37 20	12 35		
	Cape Appolonia	4 59	3 10		Nightengale Island	37 27	12 16		
	AXIM	4 53	2 55		Hibernia Rocks (doubt.)	37 31	4 42		
	Cape Three Points	4 36	2 44		Diego Alvarez (doubt.)	39 20	11 2		
	Dix Cove Fort	4 44	2 38		Gough's Island	40 19	9 50		
	Sakondoe	4 54	2 20						
	Elmina	5 2	2 00		I. Raza, N. W. point	50 59	61 23		
	Cape Corse Castle	5 7	1 52		Salvage's Isl's. N. point	50 59	61 13		
	Anamoboe Fort	5 9	1 41		The Sisters	51 7	60 26		
	Acra	5 30	0 12		Port Egmont	51 22	60 1		
Congo.	Cape St. Paul	5 52	0 48E.		Island Concha	51 15	59 00		
	Whidah	6 24	2 12		Cape Leal	51 21	58 57		
	Formosa River	5 33	4 35		Point de la Barra, N. E.				
	Cape Formosa	4 18	5 10		Point	51 28	57 41		
	New Callabar River	4 20	6 50		Cape Corientes	51 24	57 52		
	Cameroon's River	3 33	9 5		Port Soledad	51 33	59 00		
	Cape St. John	1 15	8 36		Cape St. Philip. E. P.	51 43	57 40		
	Gabon River	0 29	8 45		Beauchenes I. S. point	52 45	58 59		
	C. de Lopus Gonsalvez	0 56S.	8 43		Porpus point	52 23	59 23		
	Sesto River	2 32	9 50		Cape Meredith	52 4	60 40		
	Congo River	6 10	12 25		Cape Orford	51 56	61 00		
	Ambris Bay	7 56	13 15		Cape Percival	51 47	61 11		
	Dande Point	8 33	13 47		Aurora Isles,				
	Cape Ledo	9 43	13 28		— Northernmost	52 43	48 10		
	Novo Redondo	11 20	13 48		— Southernmost	53 25	47 59		
	St. Philip de Benguela	12 39	13 29		Eagle Reef	51 51	64 32		
	Cape Negro (appears like black hommocks)	16 00	11 54		Alexander I. Island	69 30	75 00		
	Tiger's Island, N. P.	16 30	12 1		Peter's I.	69 30	90 00		
	Cape Frio	18 40	12 42						
Caffraria.	Walwich Bay	22 55	14 40		Island Georgia,				
	Ilheca Point	23 33	14 40		— Cape Buller	53 58	37 40		
	Angra Pequena	26 37	15 16		— Cape Disappointment	54 58	36 15		
	Elizabeth Bay	27 00	15 37		— Willie's Isle	54 00	33 26		
	St. Helen's Bay, (Cape St. Martin's)	32 42	17 40		— Clerk's Islands	55 5	34 42		
	Saldanah Bay	33 7	18 7		Sandwich Land, (Cape Montague)	58 33	26 46		
	Dassen Island	33 25	18 7		— Candlemas Isles	57 10	27 13		
	Table Bay, Robin Isl.	33 49	18 25		— Southern Thule	59 34	27 43		
	Cape of Good Hope				Isle of Circumcision	54 16	6 14E.		
	Town	33 59	13 28						
	CAPE of GOOD HOPE	34 24	18 28						
XXXIX. Islands between Cape Verd, the Cape of Good Hope, and Cape Horn.					XL. From the Cape of Good Hope to Canton, with the adjacent Islands and Shoals.				
	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
S. Coast of Africa.	St. Paul's	0 55N.	29 13W		CAPE of GOOD HOPE	34 24S.	18 28E.		
	Ferdinand Noronha	3 55S.	32 35		Cape False	34 25	18 41		
	The Roccas (dangerous)	3 52	33 26		CAPE AQUILHAS, or LAGULLUS	34 55	20 15		
	Fernand de Po, N. P	3 25N.	7 36E.		Cape Infanta, S. ent. to St. Sebastian's Bay	34 35	20 54		
	Prince's Island	1 33	7 27		Cape Vaches	34 24	22 5		
	St. Thomas, (Man of War's Bay)	0 27	6 45						

*The existence of this Island is considered doubtful. Though the appearance of land is said to have been seen by several vessels in various situations, from 30° 8' S. to 30° 45' S. and from 20° 20' E. to 28° 20' E. The Island St. Matthew does not exist, being the same as Annabona.

TABLE XLVI. Latitudes and Longitudes.

271

South Coast of Africa.

East Coast of Africa.

	Lat. D. M.	Long. D. M.
Cape St. Blas, S. Mos-		
sel Bay	34 10S.	23 18E.
Cape Delgado, S. ent.		
Plettemberg Bay	34 6	23 49
Cape Mountains	34 14	26 00
Algoa Bay, Cape Recife	34 2	25 42
Chaos or Bird Islands	33 49	26 22
Dodgington Rock	33 53	26 20
Cape Padron	33 40	26 34
Rio de Infanta, ent.	33 25	27 37
Keiskammer River, ent.	33 12	28 7
First point of Natal	32 22	29 25
Middle pt. of Natal	31 8	30 45
Third pt. of Natal	30 15	31 22
Port Natal	29 55	31 28
Point St. Lucia	28 36	32 48
Smoky Point, C. Fumes	27 13	33 15
Delagoa Bay,		
— Cape St. Mary, N.		
E. P. I. St. Mary	26 59	33 15
— English River, an-		
chorage	25 58	32 41
Cape Corientes	24 2	35 51
Inhamban Bay, Sand		
Point on E. side Bay	23 47	35 52
Cape St. Sebastian, about	23 00	36 00
Bazaruta Isl. N. end,		
(about)	21 12	36 00
Sofala Bay,		
— Shoal off Sofala	20 47	35 38
— Chulawan or Holy I.	20 36	35 4
— Sofala, fort	20 15	34 45
Quilimane River, ent.	18 10	37 30
Rocky Bank	17 39	38 22
Fogo, or Fire Island, off		
Quizungo	17 12	38 52
Razor Island	17 5	39 12
Angoxa Islands,		
— Western, Caldeira	16 40	39 40
— Eastern, Mafamale	16 41	40 25
MOZAMBIQUE	15 1	40 47
Querimba Island, about	12 20	40 58
Cape Delgado	10 6	40 50
Quiloa	8 41	39 47
Zanzibar Island, S. P.	6 28	39 46
— N. P.	5 40	39 46
Pemba or Keddree, S. P.	5 30	40 19
— N. P.	4 40	40 26
Morubas Harbour, ent.	4 4	40 2
Chence River	3 37	40 7
Quilue River	3 25	40 19
Leopard's Reef	3 16	41 2
Formosa Bay, S. point	3 00	41 2
— N. point	2 39	41 21
Patia	2 10	41 16
Daedalus Shoal	0 23	43 4
Juba	0 12	43 2
Brava	1 8N.	44 10
Magadoxa	2 5	45 49
Cape Bassas	4 50	47 47
Moro Cobir Point	8 30	48 48
Cape Delgado, north	10 00	51 17
Cape Orfui	10 22	51 39
Cape Guardafui	11 50	51 38
Socotra Island, E. P.	12 30	54 52
— W. P.	12 37	53 32

Red Sea.

Arabia.

	Lat. D. M.	Long. D. M.
Socotra Island, S. P.	12 13N	
— Tamarida Bay	12 40	64 23E.
Abdul-Curna Island	12 5	52 32
Cape Felix	12 00	50 50
Cape St. Peter	11 37	50 3
Matte Island	11 21	48 59
Aia, or Burnt Island	11 14	47 28
Berbera	10 22	45 10
Zeyla	11 17	43 5
Babelmandel or Perim		
Island	12 39	43 29
Babelmandel Cape	12 40	43 32
Panther's Shoal	12 56	43 8
Red Sea	14 56	40 55
Dhalac Island	15 32	40 15
Massowah Bay	13 34	39 37
Port Mornington, ent.	18 16	38 32
Suskin	19 5	37 33
Mirza Sheik Baroud	19 35	37 24
Salaka	20 28	37 27
Cape Calmar	21 29	37 25
St. John's Island	23 39	36 10
Ras-el ans, (Cape Nose)	23 56	35 48
Reef of Breakers	24 4	36 16
Three Islands	24 25	35 26
Reef of Breakers	24 54	35 49
Dedalus Shoal	24 58	35 56
Gebel Siberget	25 2	34 54
Centurion Shoal	25 20	35 48
Kosine	26 8	34 15
The Brothers	26 19	34 47
SLEZ	30 00	32 28
Cape Jehan	23 33	33 11
Tor Harbour	28 19	33 23
Ras Nahomed	27 43	34 15
Shaduan I. S. E. P.	27 26	33 54
Bareedy Harbour	24 17	37 45
Yambo	24 10	39 21
Juddah	21 29	39 15
Camfidm	19 7	40 50
Marabia Reefs W. P.	19 11	40 5
Doorhal I.	16 15	42 8
Lohem	15 44	42 44
Gebel Tor	15 32	42 00
Cape Israel	15 15	42 41
Gebel Zabuyr	15 3	42 18
Hodeida	14 48	42 57
Shoal off Ras Magamel	14 35	42 56
Gebel Zeghur	14 2	42 52
Great Arroo	13 41	42 52
MOCHA	13 20	42 20
Cape St. Anthony	12 39	44 14
Cape Aden	12 44	45 14
Cape Hargiah	13 30	47 8
Macula Bay	13 57	47 53
Cape Bogatshua	14 6	48 22
Kiascen Point	15 19	51 20
Cape Fartash	15 34	51 56
Dofar	17 3	54 10
Cape Morebat	17 00	54 32
Cape Monteval, N.E.P.	17 33	55 20
Curia Muria, I. Western	17 33	55 40
Cape Chancelley	18 2	56 30
Cape Isolette	18 58	57 48

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long			Lat.		Long	
	D.	M.	D.	M.		D.	M.	D.	M.
Maseira Islands, S. W. P.	20	00N.	38	19E.	Surde Island	25	50N.	54	39E.
— N. E. P.	20	35	38	56	Cape Dejera	26	36	54	41
Rasalhah, (Cape Rasal-	22	22	59	58	Cape Bostana	26	30	54	52
gat)	23	20	58	57	Linga	26	33	55	1
Cape Kuriat	23	38	58	41	Kishm Island,	26	38	55	22
Muscat	23	41	57	56	— S. W. Point	26	38	55	22
Burka	25	34	56	20	— Point Bassadore, or	26	38	55	22
Point Dela	26	21	56	38	N. W. P.	26	55	55	53
Cape Mussendorn	26	22	56	42	— Luft	27	9	56	20
Azab, or Gap Island	26	30	56	44	— N. Point	26	57	56	24
Great Quoin Island	26	8	56	19	— Kishm Town	26	39	55	57
Cape Jedea	25	54	56	3	Angaum I. mid.	26	52	56	28
Rasulkhima	25	47	56	00	Lanek I. (conical hill)	27	7	56	57
Umrah, or Red Island	25	43	55	49	Ormus I. N. end, fort	27	13	56	22
Sharga	24	26	53	40	Gambroon	26	20	57	30
Zara Island	25	10	53	46	Ras Koli, or Cape Hill	25	52	57	46
Dausa Island	25	10	52	45	Kohumbarek, or Bom-	25	49	57	46
Jarnain Island	24	56	52	33	barack Rock	25	43	57	56
Arsenie Island	24	36	52	24	Cape Kohumbarek	25	38	58	10
Sear Beniyam I.	24	34	52	40	Churbar	25	16	61	20
Danie Island	25	1	52	20	Cape Gwador or Gwado	25	4	63	13
Sherarow Island	25	13	52	18	Cape Arubah	25	7	65	24
Hawlool Island, (pro-	25	41	52	23	Cape Monoxe or Mowa-	24	51	66	50
bably I. May)	26	11	51	16	ree	24	46	67	7
Ras Reccan	26	2	51	11	Korauchee or Crotchey	24	8	67	20
Koor Hussan	26	36	50	12	River Scind, ent. grand	24	44	68	17
Katif Bay, N. P.	27	42	49	30	branch	22	28	69	20
Three low sandy isls.	27	53	49	25	Tattah	22	20	69	16
Sandy Island	28	53	49	16	Bate Castle	20	42	71	6
Rasulzoor	29	20	47	57	Point Gigat	20	55	71	36
Rasuturhud, (S. E. part	28	48	48	38	Diu Head	20	55	71	43
of Graen Haven)	29	24	47	48	Jaffrabad	21	12	72	13
Mulmaradam Island	29	30	48	35	Searbett Island	22	24	72	39
Graen	29	57	48	42	Goapnat Point	21	4	72	51
Pheriecche Island	30	29	47	40	Cambay	21	11	73	5
Basra river bar	29	53	50	18	Swallow Point (Vank	20	22	73	9
BASRA or BUSSORAH	29	46	50	27	Tomb)	20	9	73	6
Delam	29	16	50	27	Surat Castle	19	50	72	49
Cape Bang	29	00	50	56	Demaun	19	18	73	13
Karak Island	29	19	51	26	Highland of St. John	18	56	72	58
Bushser	28	29	51	20	Terrapore Point	18	54	72	56
Halilah Hills, N. P.	27	49	50	4	Basseen River	18	42	72	57
Asses Ears	27	58	61	26	Bombay, (flagstaff)	18	37	72	59
Zesarine	27	49	52	6	Bombay light house	18	32	73	1
Keyn	27	24	52	52	Henry and Kenery Isl-	17	57	73	9
Cape Berdistan	26	56	54	17	ands	17	47	73	13
Konklun	26	48	53	25	Coullaba Island	17	46	73	16
Cape Nabon	26	15	50	40	Chauli	17	34	73	16
Cherak Hill	26	55	50	26	Radjapour harbour	17	25	73	16
Bushab	26	44	51	43	Bancoot River	17	16	73	17
Arad Island	26	50	51	10	Sevendroog	17	9	73	22
Durable Shoal	26	39	53	42	Dabal	16	47	73	25
Crescent Shoal	26	29	54	8	Argenwell Fort	16	31	73	25
— ditto Favourite	26	18	54	40	Boria Point	16	18	72	8
soundings	26	17	55	24	Zughur Point	16	13	72	8
Hinderabui Island	26	14	55	13	Rettna-Gerah	16	23	72	11
Kyen or Koez Island	26	6	54	34	Radjapour Port	16	3	73	36
Pokur or Belior Island	25	51	56	9	Geriah point & flagstaff				
Great Tumb L.					Angrias Bank, N. P.				
Little Tumb L.					— S. P.				
Nobfleu I.					Dewghur harbour				
Bormesa Island					Atchera River				
					Melandy (fortified Isl.)				

TABLE XLVI. Latitudes and Longitudes.

279

	Lat.	Long.		Lat.	Long.
	D. M.	D. M.		D. M.	D. M.
Malabar.			Coast.		
Newtee Point . . .	13 36N	73 39E	Punnecoil . . .	8 41N	79 30E
Angorla Rocks, or			Putacrine . . .	8 50	78 32
Burnt Islands . .	13 53	73 34	Point Ramen . .	9 17	79 22
Jares Point . . .	13 44	73 41	Devipattam . . .	9 29	79 00
Chiracole Fort . .	13 41	73 47	Tondy . . .	9 45	79 12
Chapra Fort . . .	13 36	73 48	Point Calymore . .	10 18	79 38
Vigoda Pt. N. ent. Goa			—Pagodas . . .	10 23	80 00
Bay . . .	13 29	73 53	Negapatam Fort . .	10 45	79 55
GOA . . .	13 28	74 58	Five White Pagodas of		
St. George's I. (western)	13 22	73 53	Nagore . . .	10 49	79 55
Cape Ramas . . .	13 5	74 6	Tranquebar . . .	11 1	79 55
Oyster Rocks, outermost	14 48	74 14	Devicotta (Extroon R.)	11 22	79 54
Carwar Head . . .	14 47	74 16	Porto-Novo . . .	11 31	79 48
Anjedwa (Island) . .	14 44	74 16	Cuddalore . . .	11 43	79 50
Meyco River . . .	14 30	74 31	PONDICHERY . . .	11 56	79 54
Fortified Island . .	14 19	74 37	—Palras . . .	12 38	80 13
Onore . . .	14 18	74 39	MADRAS, Fort St.		
Pigeon Island . . .	14 3	74 32	George . . .	13 4	80 22
Barcalore Peak . . .	13 50	74 52	Ennore . . .	13 15	80 24
St. Mary's Rocks, N.P.	13 24	74 53	Pulicat . . .	13 25	80 24
— S. P. . .	13 17	74 55	Arnegon . . .	13 58	80 13
Molky Pyramid . . .	13 12	75 4	Point Pennar . . .	14 30	80 17
Premeira, or Molky			Gondagam . . .	15 20	80 6
Rocks . . .	13 11	74 52	False Point Divy . .	15 47	81 1
MANGALORE . . .	12 50	75 7	Point Divy . . .	15 59	81 16
Mount Dilly . . .	11 59	75 31	MASULIPATAM . . .	16 11	81 13
Canonore Point & Fort	11 51	75 41	Narasapour Point . .	16 19	81 50
Tellicberry Flagstaff . .	11 44	75 49	Point Gordeware . .	16 44	82 22
Mahe Fort . . .	11 41	75 52	Foringa . . .	16 49	82 17
Sacrifice Rock . . .	11 30	75 51	Jagge rautporam . .	16 56	82 17
Calicut . . .	11 15	76 5	Wattara . . .	17 26	82 55
Beypore River . . .	11 10	76 6	Vizagapatam . . .	17 42	83 26
Paniany River . . .	10 38	76 17	Bandipatam . . .	17 53	83 37
Chitwa Church . . .	10 33	76 20	Chiracole R. . .	18 12	83 54
Cranganore or Aycotta			Gangem Flagstaff . .	19 22	85 10
River . . .	10 15	76 21	Manikpatam . . .	19 40	85 39
Corbin . . .	9 57	76 29	Jaggeratu Pagodas . .	19 42	85 52
Alippe . . .	9 30	76 34	Black Pagoda . . .	19 52	86 6
Porca . . .	9 20	76 39	False Point . . .	20 20	87 00
Iviker or Aybicka . .	8 54	76 46	Point Palmyras . . .	20 41	87 13
Quilon . . .	9 52	76 45	BALLASORE . . .	21 50	87 10
Angenga Fort . . .	9 39	77 00	Ingerlee Pagoda . . .	21 41	87 00
Ruttera Point . . .	4 25	77 8	Kedzerce . . .	21 51	87 6
Cadapatam Point . . .	8 9	77 29	CALCUTTA (Fort Wil-		
CAPE COMORIN . . .	9 5	77 44	ham) . . .	22 34	88 20
Caylon . . .			Chanderuagar . . .	22 51	88 27
— Point Pedro . . .	9 49	80 23	Sager Point . . .	21 35	88 11
— Colombo . . .	6 57	80 00	Light-house Point . .	21 30	88 27
— Adam's Peake . . .	6 52	80 38	Tail Western Br. ce. S.P.	21 9	87 17
— Point de Galle . . .	6 1	80 20	Tail Western Sea Reef,		
— Matura . . .	5 58	80 40	S. P. . .	21 00	87 3
— Dondra Head . . .	5 55	80 43	Tail Eastern Sea Reef		
— Grand Bassas . . .	6 11	81 34	P. . .	20 53	88 21
— Little Bassas . . .	6 24	81 55	Floating Light Vessel . .	21 2	88 25
— Elephant Point . . .	6 20	81 39	Tail of Sager Sand. S. P.	21 00	88 17
— Agaus or Aganis . .	6 53	82 1	Coja Deep Island . . .	21 27	88 54
— Battarola Roads . .	7 44	81 52	Islamabad or Chettagone	22 21	89 45
— Vendous Bay . . .	7 57	81 44	Reef Crab Island . . .	22 28	89 2
— Trincomalee, Flag-			Dombuck or Elephant		
staff Point . . .	9 33	81 24	Point . . .	21 10	89 38
— Molewal or Molatee-			St. Martin's Reef . . .	20 54	89 15
va House . . .	9 13	81 1	Mosque Point, ent. A-		
— Point Palmyra . . .	9 49	80 26	raean . . .	20 15	89 38
Manapa Point . . .	8 22	79 16	Terribles (mid.) . . .	19 25	89 6
Trinchindere Pagoda . .	8 30	79 24	Cheduha Pagoda . . .	18 8	89 32
			Free Island . . .	18 28	89 3

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Malay.									
Foul Island	18	7N	93	56E.	P. Brala, or Capas de Mer	4	47N.	103	37E.
Church (or St. John's Rocks)	17	28	91	7	P. Capas de Terra	5	15	103	8
Calventura Rocks	16	52	94	8	Tringany River, ent.	5	21	103	4
Buffalo Rocks	16	21	94	12	Great Redang Island	5	50	103	00
Cape Negrais	16	2	94	13	Pulo Printian	6	4	102	40
Diamond Island	15	52	94	19	Calantan Road	6	13	102	17
Sunken I. (or La Guardia)	15	41	94	15	Cape Patani	7	4	101	51
Rangoon, or Pegu river entrance	16	29	96	25	Pulo Lozin	7	19	102	42
PEGU	18	00	96	52	Pulo Cara	8	29	100	58
Martaban	16	28	97	30	Siam River, entrance	13	30	101	15
Tavay Point	13	33	98	6	JUTHIA or SIAM	14	18	101	13
Tavay Island	13	13	98	9	Cape Liant	12	27	101	37
Cabossa Island	12	46	97	29	Pulo Way	9	55	103	40
West Canister Island	12	40	97	25	Pulo Oby False	8	40	104	34
Tanasserim Island	12	36	97	30	Pulo Oby	8	25	104	54
Mergui	12	12	98	24	Cambodia Point	8	35	104	56
Tores Islands, western	11	50	97	3	Cambodia River, W. en.	9	34	106	30
Small Rock	11	21	97	15	Cape St. James (E. ent. Saigon R.)	10	17	107	4
Domel Island	11	10	97	57	Cape Trivoune	10	21	107	16
St. Matthew's I.	9	55	98	4	Point Balack	10	30	107	33
Seyer's Islands, N. P.	8	43	97	48	Brittos Bank, N. E. P.	10	32	107	56
— S. P.	8	28	97	48	Cow Island	10	39	107	52
Junkseylon I. N. P.	8	9	98	20	Point Kega	10	41	108	4
— S. P.	7	46	98	20	Point Vinay	10	54	108	19
Parlis River	6	21	100	13	Mui-guio or Little Cape	11	4	108	31
Elephant's Mount	6	10	100	21	Point Lagan	11	9	108	40
Queda	6	6	100	17	Pulo Ceicer de Terre	11	13	108	48
Prince of Wales' I. Fort Cornwallis	5	24	100	21	Cape Padaran	11	21	109	00
Cape Caran	3	32	101	8	Padaran Bay	11	35	109	4
Salangore Hill and Fort	3	20	101	18	Cape Varela False	11	44	109	12
Pulo Callam or Colong, S. P.	2	56	101	16	Carmaigne Harbour, en.	11	49	109	12
Parcelar Hill	2	52	101	29	Water Islands	12	3	109	19
Parcelar Point	2	42	101	32	Tre Island	12	16	109	19
Tanjong Tuan, (C. Rachado)	2	23	101	52	Pyramid Island	12	21	109	19
Tanjong Clin or Peer Punjab	2	17	102	8	Nhiatrag	12	26	109	10
Fisher's Island	2	13	102	12	Three Kings Rocks	12	43	109	23
Malacca Fort	2	12	102	15	Hone Cohe Harbour	12	45	109	12
Water Islands, southern	2	4	102	20	Cape Varela, or C. Pagoda	12	55	109	25
Mount Mora or Moar	1	59	102	42	Perforated Rock	12	59	109	25
Mount Formosa	1	49	102	56	Phuyen Harbour, ent.	13	23	109	14
Mount Battoo Ballo	1	39	103	11	Coumoug Harbour, ent.	13	29	109	13
Pulo Pisang	1	28	103	16	Pulo Cambir	13	33	109	21
Pulo Cocob	1	19	103	25	Cape Sanho	13	44	109	14
Tanjong Booro	1	15	103	30	Quinhone Har.	13	50	109	14
Little Hill, or False Johore Hill	1	26	104	6	Buffalo I.	14	11	109	14
Johore Hill	1	23	104	6	Point Nuoc Ngol	14	19	109	7
Barbucet Hill	1	25	104	13	Tanquan River	14	39	108	56
Point ROMANIA	1	23	104	18	Pulo Canton	15	23	109	6
False Barbucet Hill	1	30	104	16	Port Qui-quick	15	23	108	44
Romania Reef	1	25	104	25	Cham Callao	15	54	108	33
Eastern Bank, (outer part)	1	32	104	35	Cape Turon or Tienchu	16	5	108	15
Pulo Tingy	2	17	104	8	Callaohanne I. (N. ent. Turon)	16	11	109	7
Blair's Harbour	2	43	103	40	Cape Chouvay	16	21	107	51
Pulo Varela	3	16	103	47	Hue or Huesso River	16	35	107	26
Pahan Road	3	31			Tiger Island	16	53	107	23
Tingoram	4	12	103	18	Hainan I. and adjacent Islands,				
Howard's Shoal	4	14	103	31	— Yaitehew Bay	18	24	108	52
					— Yulenken Bay, Zenby	18	11	109	35
					— South Pt. of Hainan	18	10	109	34
					— Galong Bay	18	18	109	39
					— Brother's I's. Eastern	18	11	109	41

TABLE XLVI. Latitudes and Longitudes.

275

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Luengsoy Point S. P.	18	22N	110	00E.	Prince Edward's islands				
Sail Rock	18	26	110	8	— Southernmost	46	53S.	37	40E.
Saddle Island	18	35	110	11	— Northernmost	46	40	38	8
Point of land	18	40	110	24	Kerguelan's Land, or				
Nankin Island	18	38	110	21	Isle of Desolation,				
Tinhora Island	18	40	110	28	— Bligh's Cap. N. P.	48	29	68	44
False Tinhora	18	49	110	31	— Christmas Harbour	48	41	69	4
Toongraan Mount. pt.	19	35	111	2	— Port Paliser	49	3	69	37
Hainan Head N.E.P.	19	59	110	54	— Cape Digby, or E. P.	49	23	70	34
South Taya Island	19	19	111	12	— Cape George, or S.P.	49	54	70	10
North Taya Island	19	39	111	17	— Island Solitaire	49	49	68	11
Nowehou	20	58	110	26	— Cape Louis	49	3	68	23
Ty-soong-kyoh I. (Tien-					St. Paul's (or Amster-				
pak harb.)	21	22	111	13	dam Island)	37	59	77	59
Ty-Chook-Chow I.	21	26	111	25	Amsterdam (or St. Paul's				
Song-yue Point	21	31	111	40	Island) S. P.	38	47	77	52
Mamee-Chow, or the					Danish Rock, doubtful	28	17	98	25
Twins, near S. W. P.					Cloate's I. (lon. uncer.)	29	7	112	30
of Hai-ling-shan	21	34	111	50	Trial Rocks	20	40	105	30
Ty-oa Point	21	43	112	15	Rosemary Islands } very	30	23	115	55
Nampang I.	21	34	112	12	A reef 10 miles } near				
Mandarin's Cap	21	29	112	22	N.W. of Rose } New	20	18		
Mong-chow I.	21	39	112	29	mary Island } Hol-				
Haw-cheun, S. W. end	21	35	112	31	Abrohos Shoals } land	28	30	113	35
Passage I. (near S.W.P.					Christmas Island	10	33	105	33
Haw-cheun)	21	35	112	34	Cow Isles,				
Wy-Causs I. (near S.					— Northern	11	50	97	4
point St. John's)	21	34	112	47	— Southern	12	23	97	15
Lieu-Chow I.	21	36	112	52	Clarke's Reef and Im-				
Wizard Rocks	21	47	113	1	perieuse Shoal	17	32	119	14
Ty-kam I.	21	52	113	1	Dampier's or Scott's				
Cou-cock I.	21	50	113	7	Reef, N. W. end	13	52	121	59
Tyloo I S. P.	21	52	113	14	— N. E. end	14	1	122	16
Great Ladrone	21	57	113	44	Coral Bank	13	32	124	29
Potoe or Passage I.	22	2	113	39	Coral Bank, 9 fathoms	13	25	124	19
Laff-Samee Peak	22	8	113	49	Coral Bank, 7 fath.	12	46	124	32
Typa	22	8	113	53	Carter's sandy I. or Bank	12	28	123	56
Macao, City	22	10	113	32	Red Island, (very near				
Canton or Tyho I. S. W. P.	22	12	113	50	New Holland)	15	9	124	22
Lintin Island, Peak	22	24	113	48	Coral Bank 10 f. or less	12	25	124	11
Asses Ears	21	54	114	1	Hibernia's Shoal	11	56	123	28
Great Lema I. N. E. P.	22	5	114	18	Sahul Shoal, S. W. P.				
Nine Pin Rock	22	16	114	22	12 fath.	11	35	124	14
Whampo anchorage	23	6	113	22	Echo's Soundings, 14				
CANTON	23	7	113	14	fath.	11	16	125	50
					Coral 7 fath. Bank	9	56	129	28
XLI. Islands and Shoals in the INDIAN OCEAN, between the meridians of the Cape of Good Hope and Sumatra, including those West and North-West of New Holland.					Fortune Shoal	38	9	43	5
					Union Shoal	35	25	41	19
					Dutch Bank	31	44	44	00
					Otter's Shoal, doubtful	33	56	36	00
					Princess Augusta's Shoal				
					doubtful	33	44	36	16
					Union Rocks, doubtful	35	23	41	20
					Swallow Rocks & Break-				
					ers, doubtful	28	20	42	10
					Belliquese Shoal, doubt.	28	43	42	33
					Star Bank	25	15	44	16
					Madagascar Island,				
					— Cape Amber, N. P.	12	2	49	25
					— Cape East	15	14	50	30
					— Bay Antongil	16	27	50	28
					— St. Mary's Island	17	00	50	25
					— Foul Point	17	41	49	46
					— Fort Dauphin	25	5	46	35
					— Cape St. Mary	25	40		

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
— St. Augustine Bay					Sandy Island	15	52S.	55	23E.
ent. (Sandy I.)	23	39S	14	00E.	Galega or S. Roquepiz,				
— Cape St. Vincent	21	46	13	50	mid.	10	25	56	39
— Cape St. Andrew	16	2	15	16	Saya de Malha Bank	11	30	62	20
Madagascar Island					-- limits	8	18	59	55
— Table Cape	15	43	16	6	Fortune Bank	7	12	57	40
— Bembatooka Bay	15	43	16	28	John de Nova	10	15	51	12
— Majambo Bay	15	10	17	6	Providence Island	9	9	53	00
— Narrenda Bay	14	31	17	45	Coetivy Island	7	14	56	32
— Dalrymple Bay	13	31	18	9	Chagos Archipelago				
— Passandava Bay	13	45	18	23	— Diego Garcia	7	29	72	22
— Cape St. Sebastian	12	24	18	51		7	14		
Star Bank	25	7	14	16	-- Pitts' Bank	7	29	71	25
Bassas de India	22	28	10	37	— Centurion's Bank	7	39	70	53
Europa Rocks	21	28	40	8	— Ganges Bank	7	26	70	50
Sussex Rocks	21	25	42	36	— Owen's Bank	6	46	70	12
Bazaruto Islands	21	20	36	12	— Egmont's, or Six Isl-				
Barren Islands, western	18	26	44	15	ands	6	37	71	24
English Bank	17	40	40	15	— Danger Island	6	21	71	15
Juan de Nova or St.					— Eagle Island	6	10	71	23
Christopher's I.	17	3	43	7	— Three Brothers	6	9	71	35
Coffin Island	17	30	41	5	— Peros, Banhos Isl'ds.	5	22	71	53
Chesterfield Shoal	16	20	44	8	— Saloman's Islands	5	23	72	20
Mayotta Island	12	51	45	14	— Sandy Islands	5	17	72	37
Mohilla Island	12	20	43	50	— Speaker's Bank	5	00	72	26
Johanna Island, Peake	12	15	44	34					
Comoro	11	32	43	25	Pona Molubque Atoll,				
Portuguese Shoals	12	30	46	50	S. P.	0	41	73	20
John Martin's Island					— N. W. P.	0	34	73	12
(doubtful)	10	15	43	50	— N. E. P.	0	33	73	25
Firebrass Bank	13	16	46	20	Addon Island (mid.)	0	21	73	35
Aldabra Islands, N. W. P.	9	23	45	46	Suadiva, southern group				
Assumption Island	9	46	47	16	— South Reef	0	9N.	73	15
Cosmoledo Island	9	46	48	20	— South Island	0	11	73	12
Marquis of Huntley's					— S. W. Island	0	18	73	4
Bank	9	57	50	20	— N. W. Island	0	28	73	2
St. Peter's Island	9	28	50	42	— N. Island	0	34	73	8
Natal Island (doubtful)	8	26	47	12	— Northern group, S.				
Sandy Island	9	10	49	10	W. Island	0	48	73	19
St. Lawrence Island	9	13	50	58	— N. W. Island	0	51	73	20
Zanzibar Island, S. P.	6	28	39	46	— N. E. Island	0	58	73	33
— N. P.	5	40	39	46	Adoumatis Atoll				
Amirante Island, N. W. P.	5	10	53	45	— S. W. extremity	1	50	73	27
— S. E. P.	6	20	54	30	— Southernmost Island	1	49	73	33
Mahe Bank, N. W. P.	3	20	54	40	Island	1	51	73	38
— S. E. P.	5	30	56	59	— N. W. Island	2	7	73	35
— Seychelle or Mahe I.	4	35	55	35	— N. E. Island	2	9	73	46
— Praslin I.	4	19	55	47	Collomandous Atoll				
French Shoal	3	58	54	42	— South Island	2	13	73	21
African Islands	4	55	54	9	— Long Island	2	21	73	8
Alphonsa I.	7	4	52	49	— N. W. extremity	2	30	73	5
Sandy Island or Bank	7	16	52	49	— West entrance of				
Isle Bourbon St. Denis	20	52	55	29	Coll Channel	2	10	73	21
Mauritius or I. of France					Molucque Atoll	2	58	73	45
— Fort Louis	20	10	57	30	Nillmandous Atoll	3	12	73	18
Diego Rais or Rodrique	19	40	63	24	Poulisdous Atoll	3	36	73	44
St. Branden or Cargados					Ari Atoll, W. P.	4	17	73	2
Garajos					Male Atoll or Maldivia,				
— N. part of the Bank	13	41	61	15	S. E. P.	4	13	73	42
— Low Sandy Island	16	5	59	47	Gafer Island	4	46	73	40
— Islet with huts	16	27	59	40	Todu Island	4	42	73	14
— South Islet	16	47	59	34	Cordivia Island	5	00	73	36
Nazareth Bank, S. W. P.	16	47	59	31	Maloss Madoll	5	00	73	12
— N. E. P.	13	41	61	15	Padipolo Atoll, S. P.	5	13	73	32

TABLE XLVI. Latitudes and Longitudes.

277

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Milla Doue Malou	6	5N.	73	13E.	Nicobar Islands	Chowry I.	8 28N.	93	12E.
Tilla Dou Matis, or head of the Islands, northern limit	7	6	73	7		Terres-a I. N. P.	8 22	93	17
Minicoy or Malicoy	8	17	73	18		— S. P.	9 12	93	21
Sevelli Islands, southern	10	00	72	36		Katchall, W. end	7 54	93	29
— Northern	10	6	72	39		Nancowry I. & harbour	8 00	93	41
— Southern extreme	9	54	72	34		Camorta, N. P.	8 15	93	42
Keelam Islands, S. P.	10	4	73	56		Tillungechong I. N. P.	8 33	93	46
— N. P.	10	10	73	56		— S. P.	8 22	93	46
Courute Island	10	34	73	00		Meroe I.	7 29	93	46
Little Sand Bank	10	48	72	51		Little Nicobar, N. P.	7 20	93	52
Watercot I.	10	48	74	00		— S. P.	7 13	93	46
Aurutta I.	10	51	72	31		Great Nicobar, N. P.	7 8	93	55
Bungoro I.	10	55	73	36		— S. P.	6 45	94	00
Anguro I.	10	55	72	38	XLII. The Islands of Sumatra, Java, Billington, Gaspar, Banca, with the adjacent Islands and Straits				
Amni I.	11	6	73	8	Sumatra	Acheen	5 34N.	95	26E.
Permulpar I.	11	9	72	28		Golden Mountain	5 27	95	49
Cardamum I. (mid.)	11	14	73	12		Pedir Point	5 29	96	10
Elapeni Bank (mid.)	11	15	74	20		Elephant Mountain	5 3	96	50
Kittan I.	11	29	73	24		Tooloo-Samwoi Point	5 13	97	22
Betrapar I.	11	35	72	34		Diamond Point	5 18	97	48
Chitao I.	11	42	73	4		Tanjong Bou	1 58.	104	30
Cherbaniano Bank (not explored)	12	20	72	15		Batacarang Point	2 00	104	53
Angria Bank, N. P.	16	38	72	8		Fourth Point	2 20	105	15
— S. P.	16	18	72	9		Third Point	2 23	105	32
Isle of Cotton Rock (doubtful)	5	18	88	20		Second Point	2 41	105	41
Le Meme's Reef (doubt.)	1	20	94	20		First Point	3 00	105	58
Preparis Island, N. P.	14	56	93	40		Hog Point	5 54	105	63
— S. P.	14	49	93	40		Flat Point	6 00	104	40
Great Coco I. N. P.	14	8	93	26		Billimbing Bay	5 54		
— S. P.	14	2	93	26		Bencoonat	5 35	104	25
Little Coco I.	13	58	93	20		Cawoor	4 56	103	25
Landfall I.	13	39	93	8		Manna Point	4 33	102	53
Great Andaman						Buffalo Point	3 58	102	30
— Cape Price, N. end	13	34	93	9		BENCOOLEN (Fort Marlborough)	3 48	102	28
— S. E. point	11	30	92	56		Caytone	3 29	102	14
Port Cornwallis	13	18	93	3		Moco-Moco	2 34	101	26
Port Chatham	11	41	92	50		Indrapour Point	2 5	100	55
Port Campbell	11	56	92	39		Padang Head	0 56	99	59
Rutland I. S. P.	11	24	92	47		Prianman	0 40	99	53
Interview I. N. P.	13	1	92	46		Natal	0 30N	98	40
— S. P.	12	47	92	41		Tappanooly	1 40	98	40
North Centinel	11	33	92	24		Tappooe	2 00	97	57
South or Little Centinel	11	00	92	27		Sinkel River	2 13	97	22
Five Islands, S. P.	11	17	92	55		Troumonde	2 46	97	44
Sisters, southern	11	10	92	58		Point Labon	3 2	97	22
Brothers, northern	11	00	92	55		Point Tampot Tuen	3 15	97	16
Little Andaman, N. P.	10	53	92	38		South Tally Pow	3 22	97	11
— S. E. P.	10	26	92	40		Muckie	3 28	97	4
Invisible Bank, N. P.	11	27	93	41		Laboon Hadje	3 32	96	59
— S. P.	10	56	93	40		Mingin	3 35	96	55
Flat Rock	11	8	93	40		North Tally Pow	3 36	96	56
Barren Island	12	16	93	54		Tanger-Tangar	3 38	96	56
Narcondam	13	24	94	12		Sooso	3 42	96	50
Car Nicobar	9	10	92	56		Qualah Battoo	3 43	96	43
Betty Island	8	46	93	1		Cape Felix	3 43	96	27
						Analaboo	4 9	96	6
						Palo Rondo	6 4	95	14
						Palo Way	5 49	95	23
						Palo Rondo	5 49	95	6

TABLE XLVI. Latitudes and Longitudes.

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Pulo Rajah	4 40N.		Taggal Rock	6 46S.	
N. Cocos Islands lying N. W. of the North point of Hog Island	3 2	95 52E.	Samarang flagstaff	6 57	110 25E.
Hog Island, N. P.	2 58	96 4	— anchorage	6 53	110 24
— S. P.	2 22	96 32	Mandajique Island	6 22	110 54
Coral Bank	3 31	96 43	Lerang Point	6 35	111 27
Burgh Rock	2 47	97 26	Rambang	6 42	111 19
Shoal, 10 feet	2 48	97 33	Point Panka or Panco	6 52	113 31
Castlerough Shoal	3 5	97 6	Sourabaya	7 15	112 48
North Pulo Dua	2 52	97 39	Cape Sandana	7 49	114 22
Passage Island	2 21		Balambonang Bay, Pt. Goonug Ikan	8 23	114 25
Bird Island	1 56		— East point	8 46	114 33
Lucotta Island	1 50		Turtle Bay	7 48	109 43
Landre Shoal (N.N.E., 4 E. from Lucotta, dist. 2½ leagues)	1 57		Tulan or Direk Vrie's Bay	7 50	108 12
Meusnar Island	1 32	98 20	Wine Cooper's point	7 28	106 36
Pulo Dua	1 24	97 52			
Pulo Nvas, S. P.	0 33	97 21	Nassa Baron I.	8 38	113 35
Pulo Tainong	0 24	93 10	Tungala Islands, largest	8 26	112 26
Pulo Panjang	0 13	98 30	Clappe's Island, about	7 4	105 29
Clappe's Island, middle	0 28	97 30			
Pulo Mintan, or Patas	0 25	98 7	New Island	6 43	105 15
Pulo Ayer Besar	1 24	100 17	Peak on Prince's Island	6 35	105 15
Se-beero or G. Fortune			Peak on Crocatoo island	6 8	105 25
I. N. P.	0 56	99 33	Peak on Tamarind Isl. or Pulo Besay	5 36	105 28
— S. W. P.	1 47	99 2	Pulo Sehooko	5 53	105 26
Se-pora or South Pora, N. W. P.	2 00	99 33	Cap	5 59	105 67
— S. P.	2 35	99 58	Buiton	5 51	105 57
North Pogy Island, N. P.	2 32	100 5	Thwart-the-way	5 55	105 51
— S. P.	2 52	100 13	Zutphen Islands (larg- est) N. P.	5 50	105 47
South Pogy Island, N. P.	2 50	100 15	South Watcher	5 41	106 43
— S. P.	3 20	100 34	Maneater's Island	5 54	106 30
Laage or Larg Islands	3 30	101 11	Pulo Baby	5 48	106 14
Rat Island	3 51	102 23	Thousand Islands, N.	5 22	106 18
Trieste or Reefs Island	4 3	101 22	Pruysen's Droogte shoal	5 17	106 47
Pulo Pisang	5 8	104 6	Armuyden Bank	5 13	106 43
Little Fortune Island	5 54	104 38	North Watcher	5 12	106 32
Engano or Decit I. N. P.	5 15	102 25	Three Sisters	5 44	105 48
— E. point	5 22	102 40	North Island	5 41	105 49
— S. E. point	5 30	102 39	Two Brothers, northern	5 9	106 5
— S. point	5 31	102 29	Lynn Shoal	5 12	106 13
— W. point	5 21	102 19	Shabunder Shoal	5 9	105 58
			Brouwer's Shoal	5 5	106 14
Java Head	6 48	105 11	Lucepera Sent St. Banca	8 12	106 10
First Point	6 44	105 12	Nanka Islands	2 25	105 48
Second Point	6 36	105 21			
Third Point	6 27	105 40	Banca Island		
Anger	6 3	105 54	— South Point	3 6	106 40
Bantam or St. Nicholas P.	5 53	106 2	— Tanjung Panjong or Pont Lalary	2 49	106 4
Bantam	6 5	106 10	— Monopin Hill	2 00	105 14
BATAVIA Observatory	6 9	106 52	Tanjung Goonting	1 43	105 20
Carawang Point	6 1	107 12	— Tanjung Muncooda		
Sedary Point	5 59	107 27	N. of Banca	1 28	105 51
Point Tamaroekan	6 11	107 49	— Tanjung Tuan	1 38	106 6
Woerden Castle Rock	6 2	107 52	— Songy Leat Bay	1 50	106 9
Princess Charlotte Shoal	5 58	107 54	— Tanjung Ryah	1 55	106 14
Indramaye Point	6 15	108 20	— Goonong Marass Mount	1 53	105 52
Pulo Rakit	5 56	108 22	— Tanjung Breket	2 36	106 52
Bumkin's Island or out- er Shoal	5 47	108 23	— Rocky Point	2 56	106 54
Cheribon Mountain		108 24	— Entrance Point, or S. E. P.	3 2	106 54
Taggal	6 50	101 11			

TABLE XLVI. Latitudes and Longitudes.

279

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Shoal or Fairlie	3	27S.	107	2E.	Bintang I. N. W. P.	1	10N.	104	19E.
rt's Shoals	3	11	107	2	Johore Shoal	1	13	104	4
at or Middle I.	2	51	107	5	Shoal ent. Rhio Straits	1	8	104	11
Shoal	2	46	107	2	Sineapour I. E. P.	1	22	104	00
Water Island	3	20	107	13	Pulo Battain, N. E. P.	1	10	104	4
dand	3	00	107	15	St. John's I. S. P.	1	14	103	51
land	2	58	107	15	Rocky Reefs	1	9	103	55
Hewitt's Rock	2	53	107	14	Middle Island	1	13	103	46
ry Rock	2	54	106	56	Coney Island	1	9	103	41
ana or Gasper I.	2	25	107	6	Buffalo Rock	1	9	103	48
and	2	28	107	00	Rocks	1	6	103	45
Hasting's Shoal	2	23	106	57	Red Island	1	6	103	38
e's Shoal	2	15	107	00	Tree Island	1	8	103	36
rt's Shoal	2	11	106	46	Alligator Island	1	10	103	40
ough Shoal	2	3	106	22	Rocks	1	12	103	36
n's Shoal	1	56	107	1	Little Carimon	1	8	103	24
Shoal	1	40	106	26	Great Carimon, N. P.	1	7	103	21
Island, S. E. P.	3	22	108	15	The Brothers	1	10	103	21
. Point	3	15	107	35	Pulo Cocob	1	19S.	103	25
	2	33	107	53	Pulo Pisang	1	28	103	16
land off Billiton	2	35			Water Islands, or Four				
land (formerly					Brothers, S. P.	2	4	102	20
. and White R.)	3	47	108	2	Fisher's Island	2	13	102	12
al	3	32	110	4	Barnbeck Shoal	2	37	101	41
ncap	3	5	110	11	Pulo Callam or Colong,				
cap Shoal, S. P.	3	22	110	11	S. P.	2	56	101	16
ry's West. Bank	3	39	108	43	Two and half fathoms				
ern Bank	3	33	109	10	Bank	2	54	101	4
	3	36	109	43	Round Arroa	2	49	100	49
s North Shoal	3	19	108	40	Blenheim's Shoal	3	3	101	2
ster's Sand Bank	3	17	109	5	Long or Great Arroa	2	52	100	44
I	2	54	108	58	Two Brothers, Pulo				
in Islands south	2	35			Pandan	3	24	99	54
ern	2	31	108	52	— Pulo Salanama	3	21	99	52
rockemou (high-					Pulo Varela	3	47	99	36
l.)	2	31	108	36	Pulo Jarra	4	00	100	14
ocks	2	14	109	51	Sambihang I. Southern	4	3	100	35
's Shoal	2	1	108	39	Dinding I. W. P.	4	16	100	35
rous I.	2	44	110	3	Prince of Wales' I. Fort				
ou, W. P.	1	42	108	41	Cornwallis	5	24	100	21
a I. Peak	1	36	108	54	Pulo Pera	5	42	99	1
pan	1	28	109	26	Boonting I. Southern	5	45	100	18
numbangan	1	12	109	14	Pulo Bonton (Dome)	6	33	99	20
leega Isles	0	55	109	18	Pulo Ladda, S. P.	6	8	99	42
Shoal	0	55	108	39	Trotto I. N. P.	6	49	99	39
					Sangald or Guilder Rock	7	10	98	50
en Islands, N. W.	1	8	105	24	Pulo Telibon	7	14	99	29
rela or Barallah	0	54	104	20	The Brothers	7	31	98	20
ya	0	45	104	58	Pulo Rajah or P. Taya	7	36	98	20
antigas	0	35	103	51	Junkseylon, S. P.	7	46	98	20
Shoal	0	26	105	2					
Tanjong Reng,					XLIII. Islands and Shoals in the CHINA				
ext.	0	20	105	4	SEA.				
mino Island	0	10	105	4					
Bank, same as									
er Bank	0	48N.	104	58					
	0	57	104	30					
Island off Pulo									
ng	0	54	104	56					
	0	48	104	51					
Brothers, south	0	31	103	44					
Tranco	1	20	104	26					
off P. Romaine	1	23	104	21					
I. (the hill)	1	2	104	30					

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
<i>Anambas I.</i>	Rocky Island	1	9N.	107 14E.	Round Island or Great Catwick	10	6N.	108 52E.	
	Camel's Hump	1	10	106 55	Pulo Ceicer de Mer	10	32	108 53	
	Saddle Island	1	16	107 4	Minerva's Bank	10	37	110 19	
	French White Rock	1	32	106 32	Investigator's Coral Patch	14	12	112 52	
	Victory Island	1	34	106 22	Triton's I. or Bank S. W. part	15	45	111 11	
	Acastee Rock	1	39	106 21	Passoo Keab (Sandy I.)	16	3	111 45	
	White Rock	2	18	105 35	Bombay Merchant's Shoal, E. P.	16	4	112 38	
	Macedonian Reef	2	25	105 32	— S. P.	15	59	112 26	
	South Anambas, limits	2	18	106 8	Discovery Shoal, W. P.	16	11	111 32	
	Pulo Domar	2	45	105 27	— E. P.	16	16	111 46	
	Middle or G. Anambas, W. limit	3	9	105 41	Jehangire's Coral Bank	16	18	112 35	
	North Anambas	3	27	106 15	Vulador's Shoal, E. P.	16	19	112 7	
	Pulo Tingy	2	17	104 8	— W. P.	16	18	112 00	
	Ex. Islet off P. Tingy	2	8	104 11	Crescent Chain				
	Pulo AOR or Wawoor	2	29	104 35	— Money's Island	16	23	111 30	
	Pulo Pisang or Pambeelan	2	37	104 21	— Robert's Island	16	31	111 34	
	Pulo Fimoan, S. P.	2	44	104 15	— Pattle's Island	16	33	111 36	
	— N. P.	2	54	104 15	— Drummonds's Island	16	29	111 44	
	— Bay on S. W. side	2	48		— Governor Duncan's Island	16	27	111 40	
	— N. Islet off N. W. side	2	56		— Antelope's shoal	16	27	111 35	
<i>Natunas Islands.</i>	Pulo Varela	3	16	103 47	Observation Bank N. P.	16	37	111 41	
	Pulo Brala or Capas de Terre	4	47	103 37	Pyramid Rock	16	35	112 37	
	Pulo Capas de Terre	5	15	103 8	Lincoln Island	16	41	112 42	
	St. Pierre Islands	1	56	108 53	Rocky Island	16	52	112 20	
	— Ledge of Rocks	1	53	108 52	Woody Island	16	50	112 18	
	Larkin's Reef	2	11	109 16	Amphitrite Islands, W. P.	16	59	112 12	
	South Haycock Island	2	13	108 57	— E. P.	16	54	112 23	
	South Natuna's Islands				North Shoal, W. P.	17	5	111 26	
	— South Island or Sapata	2	28	109 8	— E. P.	17	6	111 32	
	— East Island	2	42	109 26	Macclesfield Bank, limits	15	17	113 44	
	— West Island	2	42	108 40	Scarborough or Marsingola Shoal, limits	15	4	117 44	
	— North or Flat Island	3	3	108 54	St. Esprit Shoal (by Lt. Ross)	19	30	113 6	
	Low Island	3	00	107 49	— (by Asseveido)	19	6	113 5	
	Hutton's Shoal	3	2	107 57	Pratas or Prater's Shoal				
	Diana Shoal	3	9	107 44	— N. E. P.	20	47	116 54	
	North Haycock Island	3	20	107 36	— N. W. P.	20	45	116 43	
	Grand or Great Natuna I. limits	3	40	108 26	— Anchorage	20	43	116 41	
	— Peaked Island	3	54	108 10	— Island	20	43	116 45	
	Pyramidal Rocks	4	5	107 24	Great Ladrone	21	57	113 44	
	— N. W. Island	4	7	107 52	[The Islands near Canton are given in No. XI. and in No. XLVI.]				
<i>S. E. Part China Sea.</i>	— Coral Reef	4	1	107 50	Pedro Branco	22	19	115 9	
	— Coral Reef	3	57	107 47	Lamock Islands, outermost	23	14	117 19	
	North Natuna Is. S. P.	4	42	107 58	Andrade Rock (very doubtful)	9	56	111 4	
	— N. P.	4	49	108 2	Luconias Shoals				
	— Rock above Water	4	39	107 57	— Hard Rocks	5	24	112 30	
	— Saddle Island	4	33	107 46	— Two Fathom Shoal	5	5	112 24	
	— Success Shoal	4	25	107 57	— Dry Sand	4	57	112 30	
	Pulo Oby	8	25	104 54	Sea Horse Reef	5	35	112 23	
	The Brothers (eastern)	8	35	106 18	— Half Moon Breakers	8	46	116 30	
	Pulo CONDORE	8	40	106 42	— Bank	10	57	117 53	
	Charlotte's Bank	7	5	107 39					
	Phæton Bank	7	00	107 29					
	Royal Bishop's Bank	9	44	108 21					
	Britto's Bank, N. E. P.	10	32	107 56					
	Holland's Bank, S. W. P.	10	36	108 32					
	— N. E. P.	10	48	108 47					
	Pulo SAPATA	10	1	109 2					
	Pyramid Rock or Little Catwick	10	2	109 00					

TABLE XLVI. Latitudes and Longitudes.

281

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Paraquas, 5 or 6 leagues from Palawan .	9	10N	117	23E.	Breakers* .	11	10N.	112	54E.
Euphrates Shoal .	5	38	113	24	Falmouth's (or Essex) low Island*)	10	58	112	40
Kirton's Shoals .	5	39	113	15	— Bank, or Gossard's B.	11	25	114	13
— ditto .	5	49	113	2	Essex (or Falmouth) low Island* .	11	2	112	40
Louisa's Breakers .	6	20	113	18	Gossard's Reef (or Middleburg R.) .	8	58	111	5
Mentannane Isles .	6	39	116	7	— Small Island .	10	42	113	26
Barton's Shoals .	6	55	116	6	Cornwallis Breakers .	10	00	114	26
Royal Charlotte's Rocks .	6	57	113	38	— ditto .	8	49	114	14
— Sands .	10	47	114	29	Sabut Jung low Island .	11	32	113	29
Swallow or Investigator's Rocks .	7	23	113	44	— Bank .	11	34	113	51
Viper's Bank .	7	30	115	7	Gaspar Shoals .	11	36	113	51
— Breakers .	8	00	115	25	South Sea Castle's Sandy Islands and dangers, limits (by Lieut. Ross) .	11	29	114	24
Ardasier's large coral flats and gaps .					— do. .	11	21	114	16
— W. P. (Walpole, Cornwallis and A.) .	7	56	113	12	Two Islands .	11	27	114	22
— N. E. P. (Walpole and A.) .	7	54	114	24	An Island (Investigator) .	11	8	114	18
— E. P. (Ardasier) .	7	40	114	47	An Island ditto .	10	44	114	26
— S. P. (Pennsylvania and A.) .	7	30	114	34	A Reef .	10	15	113	40
Gloucester Shoal .	7	47	114	50	Discovery's Reef .	10	00	113	50
Stag's Shoal .	8	24	112	57	— ditto .	10	8	113	50
Prince of Wales Bank { limits .	8	3	110	24	York Breakers .	9	50	117	48
London Breakers .	9	36	112	26	Pennsylvania Breakers .	9	17	114	43
— Reef, western .	8	55	112	00	— ditto .	8	48	115	17
— do. eastern .	8	48	112	24	— ditto (Viper's) .	8	58	115	21
— Breakers .	7	33	113	14	— ditto .	9	4	115	17
— ditto .	7	22	113	8	— ditto .	10	10	115	20
Ganges Breakers .	9	22	114	12	— ditto (Fanny) .	9	45	114	49
— ditto .	10	30	115	10	— ditto .	9	32	116	34
Investigator's Shoal W. P. .	8	5	114	35	— ditto .	9	47	116	58
— E. P. .	8	10	114	51	— ditto .	9	52	116	48
— Shoal .	9	12	116	32	— ditto .	10	23	116	49
— Shoal .	10	44	114	34	— ditto .	10	49	117	10
— Coral Rocks .	9	40	113	4	XLIV. Islands and Shoals between Borneo and New Guinea, South of the Celebes.				
— ditto .	9	42	113	15					
Cavallo Marino's Shoal .	5	51	111	18					
— ditto .	8	31	114	21					
— Black Rocks .	9	39	114	58					
— Bank .	10	19	115	7					
— White Sand .	10	49	115	13					
— Low Black Island .	11	1	115	17					
Friendship's Shoal { .	5	52	112	34					
Hardwick's Reef* (or Dolphin's) .	6	00	112	49					
— Breaker's* (ditto) .	9	54	112	17					
Royal Captain's Shoal .	10	2	112	12					
Bombay's Shoal .	9	4	116	43					
Dolphin's Reef* (or Hardwicke's) .	9	27	116	55					
— Breakers* .	9	59	112	17					
— Breakers* (ditto) .	9	45	112	30					
Great Reef, N. P.* .	10	9	112	15					
— Long Island* .	10	7	112	9					
— Breakers* .	10	17	112	35					
— First Island* .	10	22	112	31					
— Ledge* .	10	35	112	38					
— Breakers* .	10	40	112	47					
	10	46	112	47					

* The longitudes of these places ought probably to be increased.

M m TAB.

TABLE XLVI. Latitudes and Longitudes.

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Great Paternoster's Is.			Bally Island.		
W. P.	7 15S.	117 00E.	— Table Point or S. P.	8 50S.	115 2E
— S. W. I.	7 32	117 16	— Volcano	8 24	115 24
— S. I.	7 34	117 30	— N. E. P.	8 19	115 43
— Two low islands	7 36	117 55	Bally Straits, S. ent.	8 50	114 40
— E. P.	6 42	118 40	A shoal near the anchor- age at Balambuag, bears S. W. $\frac{1}{4}$ W from the flagstaff, distant $\frac{1}{2}$ mile from shore		
Postillion's Islands, N.			Mynder's Rocks	7 41	114 23
W. P.	6 32	119 48	Banditti Island	8 46	115 15
— Eastern Island	6 45	119 15	Lomboek I. S. P. about	8 50	116 00
— ditto, S. P.	6 55	119 5	— Peak, near N. E. P.	8 21	116 26
Noesa Sera Islands	5 2	117 9	— North Point	8 11	
Noesa Comba, about	5 15	117 9	Lomboek I.		
S. Bank off Noesa Comba	5 46	117 00	— Isles near N. W. P.	8 13	115 59
Caloeohij or Rotterdam I.	5 15	117 36	— Ampannan Riv. ent.	8 33	
Hen & Chickens, S. P.	5 28	117 54	— Loboagee or Bally Town	8 42	116 33
Zalinnaff or Saffannaff or Laer's I.	5 31	118 25	Selonda Island	8 8	117 44
— Coral Bank off ditto, S. P.	5 54		Pulo Mayo or Mayo N. P.	8 7	117 31
— ditto, E. P.		118 26	Flat Island	9 9	117 25
— ditto, W. P.		117 58	Sandbuy's 4 Shoals, { limits	7 42 7 56	117 13 119 3
— Five Fathoms Bank	5 52	118 20	Sumbava I. S. W. P.	9 2	116 42
Tony Islands, S. W. I.	5 31	118 36	— Timor Yung I. (off N. W. P.)	8 21	116 57
— E. I.	5 31	118 46	— Sumbava Bay	8 27	117 24
Shoal	5 27	119 5	— Tumbora Mountain	8 9	117 43
Tanakeka or Tunikik I.	5 34	119 24	— Biema Bay, rugged point	8 11	118 51
Brill Shoal, N. P.	6 00	119 2	— ditto, rocky point	8 8	118 36
— S. P.	6 5	119 00	— Sapy Bay, anchorage	8 30	119 3
Mansfield Shoal	5 45	120 13	— S. E. Point	8 42	119 14
Middle Island	5 10	120 28	Goonong Apee I Peak	8 11	119 5
Salayer I. N. P.	5 49	120 29	Comodo Island	8 22	119 37
Cambyna I. S. P.	5 30		Flores or Mangerye I. S. W. P. about	8 50	
— Peak	5 21	121 1	— S. P. about	9 00	121 39
South Island	5 40	122 30	— Lobetobie Volcano	8 32	
Hegadis Island	6 13	122 40	— N. P. Flores Head, or Iron Cape	8 5	123 1
Bouton Island, S. P.	5 42	122 44	Straits of Flores, S. en.	8 40	123 3
— Town	5 27	122 48	Sandal Wood I N. P.	9 15	
— N. E. Point	4 23	123 4	— Bluff or West P.	9 42	119 00
— Calansoesse Harbour	4 55	123 11	— S. extremity	10 22	120 20
— East Point	5 15	123 15	— E. end	10 00	120 35
Token Bessy's Islands,			— Padewawy or Bar- ing's Bay	9 37	
— Wangiwangi, N. W. I.	5 15	123 33	Savu Island	10 37	122 00
— Pinnunko S. P.	6 14	124 1	New Island	10 46	121 3
— Velthoens or Koko I.	5 59	124 48			
— ditto	6 10		Pulo Comba or Cambay	7 49	123 41
St. Matthew's Islands,			Lombien I. Peak (on N. W. P.)	8 12	123 52
(mid.)	5 18	124 16	— E. Point	8 14	124 00
Mamalakjee I. (N. W. Tonin I.)	6 41	120 14	Pantar I. N. E. P.	8 10	124 8
Schiedam Islands, N. W.	7 1	120 28	East Island, Str. of Aloo	8 20	124 00
— S. E.	7 12	120 56	Middle Island, ditto	8 23	122 55
— Shoal	7 27	121 13	Ombay or Mallao I.		
Kalaton Island	7 12	121 40	N. W. P.	8 9	124 17
Alfred's Shoal	7 9	121 36	— E. P.	8 17	125 16
Jagger's Reef or Banga- lore Shoal, about	7 40	121 13	Botto or Rottel. S. W. P.	11 2	127 65
— ditto, another esti- mate		121 46			
Angelica's Shoal	7 35	121 58			
— ditto, another esti- mate	7 40	122 18			
Rusa Raji or Lusardy I.	8 17	121 38			
Rusa Linguette or Ro- sagalet I.	8 5	122 00			
The Three Bastards	8 14	122 41			

TABLE XLVI. Latitudes and Longitudes.

	Lat. D. M.	Long. D. M.		Lat. M. D	Long. D. M.
Lucena.			Mindoro.		
Sangboys or Hare's Lips	6 48N	121 41E	Group of Islands, S. P.	12 8N	120 23E
Teynga Island	6 52	121 43	N. P.	12 17	
Catanduanes I. S. P.	13 38	121 15	Turret Island	12 22	120 10
C. del Espiritu Santo.			North Rock	12 27	120 4
N. E. P. Samur I.	12 40	123 33	Mindoro I. S. P.	12 11	121 22
St. Bernardino Island	12 46	124 33	— Point Dongan or		
Ticao I. Port St. Jacinto	12 34	123 34	Pandan	12 48	120 55
			— Point Calavite	13 27	120 20
Manilla	14 36	121 2	Luban	13 44	120 13
Cavite	14 29	120 55	Goat Island	13 51	120 7
Ent. Manilla Bay	14 28		Babuyan Islands		
Point Capones	14 52	120 3	— Lapurip or Dalu-		
Two Sisters Islands	15 50	119 47	peri I.	19 15	121 34
Point Boliano	16 27	120 00	— Fuga or New Babu-		
Cape Bajador	18 42	121 00	yun I.	19 1	121 43
Point Cavnaion	18 48	121 14	— Camaguin I.	19 4	122 12
Cape Enganno	18 39	122 21	Babuyan Islands,		
Maruban	14 8	121 44	— Gounapac Rocks	19 5	122 25
Cape St. Ildefonso	15 25	121 46	— Diduas Rocks	19 12	122 31
			— Claro (or Old) Ba-		
Samboongan	6 53	122 14	buyan	19 37	122 17
Point Balagonan	7 51	122 24	— Calayan I.	19 23	121 46
Suriago village, near N.			Bashee Islands.		
Point	9 47	125 25	— Balintang or Rich-		
Cape St. Augustine, S.			mond Isles	19 58	122 24
E. P.	6 4	126 48	— Sabtang I.	20 14	122 12
South or Serangi Point	5 39	125 32	— Bashee I.	20 14	122 9
Mindanao	7 10	124 35	— Goat I.	20 15	122 7
			— Batan or Montmouth		
Negros, South Point	9 6	123 3	I. S. P.	20 17	122 15
— Point Bojoton	9 50	122 32	— ditto Mount, N. P.	20 23	122 21
Cagayan Islands, mid	9 34	121 23	— Grafton or High		
Panay I. Point Nasog.			Round I.	20 34	122 13
S. P.	10 25	122 6	— Bayat or Orange I.	20 37	122 7
— Asleman village	10 32	122 6	North Bashee, High I.	21 3	122 6
— Point Potoh or N. P.	11 48	122 2	— Northernmost I.	21 9	122 6
Dry Sand Bank	11 24	121 54	Gadd's Reef	21 43	121 43
Sombrero Rock	10 45	121 37	Cumbrisan's Reef, doubt-		
White Rock	10 28	121 21	ful, probably the same		
Cuyo Islands			as Gadd's Reef	21 35	121 45
— Quinluban (North-			Little Botel Tobago		
ern Island)	11 29	121 11	Xima	21 56	121 45
— Grand Cuyo	10 52	121 21	Botel Tobago Xima	21 59	121 43
— Southern I.	10 40	121 31	Vie-rette Rocks	21 42	120 58
Caravos or Buffalos	11 53	121 48	Formosa f. South Cape	21 54	121 00
Betsey's Bank, 5 fathoms	11 42	120 57			
Ylin Islands, S. P. off S.			Gomano Island	1 56 S	127 35
P. Mindoro	12 9	121 13	Lissamatula I. S. E. P.	1 46	126 27
Cornal Shoal, West of			Xulla Beasey, S. E. P.	2 29	126 58
ditto, about	12 11	120 57	— N. E. P.	1 58	
Apo Bank, S. P.	12 36	120 53	— N. W. P.	1 58	125 48
— E. P.	12 40	120 56	Xulla Mangola, W. end	1 43	
— N. P.	12 45	120 31	Greyhound Straits	1 40	124 30
— S. W. P. (Islet)	12 40	120 29	Haycock I. off S. W. P.	1 56	
— West. or Great Islet	12 39	120 29	Xulla Talaybo	1 58	124 36
— Discovery Bank	12 40	120 43	Skelton's Island, on N.		
Coron Island	11 46	120 12	W. P. ditto	1 45	124 36
Green Island	12 3	119 40	Middle Island	1 45	124 28
Haycock	12 9	119 51	Albion's Island	1 53	124 19
Pinnacle Rock	12 18	119 54	Bouro Island, N. W. P.	3 6	125 57
N. W. Rock	12 23	119 55	— N. ext.	3 2	
Sail Rock	12 22	119 56	— N. E. P.	3 15	127 5
Busvagnon I. N. P.	12 19	119 56	— Cayeli or Boura Bay	3 24	127 4
Calavite or High I.	12 21	119 56	— South Point	3 49	
			Amblaw Island	3 52	127 14

TABLE XLVI. Latitudes and Longitudes.

227

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Symplegades Islands, S.					Raakok Island	48	8N.	153	15E.
W. P.	31	26N.	129	37E.	Mussir Island	48	16	153	15
Meac-Sima I. S. W. P.	31	35	129	40	Trap Rocks	48	36	153	44
— N. E. P.	31	49	129	51	Charamukatan I. Peak	49	8	154	39
Nadeshda Rocks	31	42	129	33	Poromuscher I. S. P.	50	00	155	24
Tsus I. S. end	34	6	129	17	— Peak Funs (S. W. P.)	50	15	155	10
— Cape Fida-Buengono	34	19	129	30	— East Point	50	28	156	9
— North Point	34	40	129	29					
Colnett's Island	34	16	129	56	XLVII. NEW HOLLAND and the adjacent Islands and Shoals.				
Dagelet I. N. E. P.	37	23	131	22					
Nippon I.									
— South Point	33	5	135	55					
— Cape Noto	37	36	137	54	Pedro Branco (Rubrick)	44	00S	147	45E.
— A Rock	37	36	137	34	South West Cape	43	34	146	6
— Jootsi-Sima	37	51	137	40	Mew Stone	43	42	146	28
— Jedo	36	29	140	00	South Cape	43	33	146	49
— Cape Kennis	37	10	141	30	Eddystone	43	51	147	8
— Zach's Mountain	35	25	132	20	Sidmouth's Rock	43	46	147	9
— Russian's Promontory, S. P.	39	46	139	44	Tasman's Head	43	32	147	26
— N. E. P.	40	00			D'Entrecasteaux's Port	43	32	147	6
— Town	40	50	140	6	Adventure Bay	43	21	147	32
— Cape Gamally	40	38	139	48	Frederick Henry Bay	42	58	147	42
— Peak Tilesius	40	40	140	11	Cape Pillar	43	12	148	9
— Cape Greig	41	9	140	8	Oyster Bay	42	42	148	8
— Cape Sangar (ent. Straits of Sangar)	41	16	140	14	St. Patrick's Head	41	48	148	22
Osima Island	41	31	139	19	Cape Portland	40	49	148	15
Kosima Island	41	21	139	46	Port Dalrymple	41	3	147	11
Okosir Island (middle)	42	9	139	30	Circular Head	40	43	145	15
Jesso Island					Cape Grim, N. W. Prom	40	41	144	45
Cape Nadeshda (ent. of Straits of Sangar)	41	25	140	9	West Cape or Sandy Pt.	41	4	143	36
— Cape Sinoko	41	38	133	53	Marquarie's Harbour	42	12	145	28
— Matzumay town	41	32	140	4	Point St. Vincent	43	16	145	55
— Cape Oota-Nizawu	42	18	139	46	Port Davey	43	23	146	00
— Cape Kutusoff	42	38	140	1					
— Cape Rayten	42	57	140	16	Ent. to Bank's Straits	40	38	148	20
— Cape Okamay, S. P.	43	11	140	13	Furneaux Islands,				
— Cape Taka-sima	43	21	140	31	— Barren I. S. E. ext.	40	25	148	26
Mount Rumoffsky	42	50	141	11	— Clarke's I. S. ext.	40	34		
— Cape Malespina	43	42	141	18	— N. Sister, near N. P. of Great Island	39	38	147	56
— Cape Schischkoff	44	25	141	32	Endeavour Rock	39	38	147	35
— Pallas Mountain	44	00	141	54	Kent's Group	39	29	147	17
— Cape Romanzoff (N. Point)	45	26	141	34	The Pyramid	39	49	147	13
— Cape Soya	45	31	141	51	Waterhouse Island	39	39	147	32
— Cape Shap	45	21	142	12	Hunter's Islands				
Peak de Langle, Roachery I.	45	11	141	12	— Black Pyramid, W.	40	33	144	22
Cape Guibert, Reischery N. E. P.	45	28	141	4	— Albatross I. N. West	40	25	144	35
Jeurire Island	44	28	141	17	King's Island N. E. P.	39	36	143	55
Janikesseri Island	44	29	141	23	West ent. Bass's Straits	39	10	143	30
Staten Island, S. W. end	44	26	147	23	Cape Albany Otway	38	53	143	30
— Cape Vries, (Vries Straits)	45	26	149	43	Port Philip, ent.	38	19	144	36
Company's Island					Western Port	38	31	145	10
— Cape Shouten	46	18	150	58	Wilson's Promontory, S. ext.	39	11	146	24
— North end	46	28	151	20	Ram Head	37	39	149	45
Marikan I. N. end	47	10	153	6	Cape Howe	37	30	150	7
South end (Bousole Straits)	46	46	152	32	Cape D. omedary	36	18	150	9
Sarytscheff I. Peak	48	6	153	12	Jervis Bay	35	7	150	58
					Red Point	34	29	151	14
					Botany Bay, entr. (C. Banks)	34	00	151	23
					Port Jackson, ent.	33	50	151	25
					Broken Bay	33	34	151	27
					Port Stephens	33	43	152	10

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Cape Hawke	32	13S.	152	30E.	Rica de Plata	33	50N.	160	39E.
Smoky Cape	30	51	153	7	Reef	32	00	147	00
Solitary Islands	30	9	153	21	Island	31	30	140	00
	29	56			Week's Reef 36' N. E.				
Cape Byron	28	7	153	30	and S. W.	31	15	153	9
Point Danger	28	7	153	30	Island	31	00	147	6
Shoals off ditto	28	7	153	39	Ganges Island	30	45	154	25
Cape Morton	27	1	153	23	Bank of Soundings	30	30	177	30
Shoal	26	58	153	23	Island	30	00	137	00
Sandy Point	24	42	153	17	Island	30	00	139	00
Cape Capricorn	23	29	151	00	Island	30	00	141	30
Keppel Bay	23	18	150	36	Island	30	00	143	00
Barrier Reef, S. P.	22	50	152	36	Island	30	00	144	24
Cape Townsend	22	12	150	11	Rica de Oro	29	54	157	3
Cape Palmerston	21	27	149	00	Island	29	40	143	00
Cape Hillsborough	21	00	148	33	Island	29	33	137	00
Cape Conway	20	32	148	30	Island	29	30	143	00
Cape Gloucester	19	58	148	6	Island	29	00	175	45
Cape Cleveland	19	10	146	40	Calunas I.	28	55	158	00
Cape Sandwich	18	16	146	8	ditto(another account)	28	53	162	00
Cape Grafton	16	51	145	54	Island	28	30	176	50
Cape Flattery	14	52	145	18	Patrocinio Island	27	58	175	44
Cape York	10	38	142	33	Disappointment Island	27	19	139	25
New Year's Island	10	48	133	18	St. Juan	27	30	142	48
Vandiemans Cape	11	12	129	54	Bassiosos I.	26	6	173	27
Red Island, off P. Vulcan	15	9	124	22	Island	26	6	154	36
Minstrel's Shoal	17	14	118	57	Reef	26	6	160	00
Greyhound Shoal	19	58	114	40	Copper Island	26	00	131	48
Clarke's Reef N. of					Tree Island	26	00	145	44
Rosemary I.	20	17			Lasker's Island	26	00	173	24
Eastern Rosemary I.					Island	25	53	131	17
N. E. P.	20	26			Island	25	42	131	13
Western ditto N. P.	20	35	115	40	Reef	25	30	152	50
Doubtful Shoal	21	37	112	25	Bishop's Rock	25	22	132	00
Piddington's Islands	21	36	114	56	North Island	25	14	141	14
Shoal (land of N. Holland in sight from the mast head)	20	15			Island	25	12	131	36
North West Cape	21	50	114	25	Grampus Island	25	10	146	00
Dirk Hartog's Road, ent. to Shark's Bay	25	6	113	15	Sulphur Island	24	48	141	30
Houtman's or Abrohlos Shoals	28	30	113	35	Kendrick's Rock	24	30	133	36
Rottenest Island	31	58	114	24	Marcus Island	24	18	153	42
Cape Leuwen or S. W. Cape	34	22	115	6	Weeks Island	24	00	154	00
Cape Chatham	35	3	116	22	Dexter's Island	23	24	163	5
Cape Howe	35	9	117	38	Island	23	3	162	57
K. George III. Harbour	35	6	118	1	Reef	22	6	142	22
Point Hood	34	23	119	36	Jardines	21	35	151	30
Termination Island	34	30	121	58	Parel or Peru I.	31	10	141	40
Endeavour, small Isl.	36	27	127	2	Abregoes Shoal	21	1	136	43
Port Lincoln	34	48	135	45	Reef	20	42	153	00
Nepean Bay	35	44	137	55	Douglas Reef	20	32	136	12
Endeavour Shoal, off Cape Jaffa	36	58	139	31	Lamira I.	20	30	166	42
					Island	20	30	152	50
					Bishop's Rock	20	16	136	53
					Week's or Wilson's I.	19	21	166	55
					Reef	19	10	165	42
					Halcyon I.	19	6	163	33
					Folger's I.	18	22	155	15
					Reef	17	9	156	13
					Tarquin I.	17	00	160	00
					Reef	16	36	169	42
					Island	16	00	171	42
					Pajaros Islet, northern.	20	34	145	48
					Urracas, about	20	20	146	15
					Assumption Island	19	45	145	35
					Almagan Island	18	6	146	21

TABLE XLVI. Latitudes and Longitudes.

289

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Bird Island . . .	16 47N	146 13E.	Johannes . . .	6 55N.	132 30E.
Tinian . . .	15 00	145 47	Lion's Island . . .	5 16	132 13
Guam, Umatac Bay . . .	13 21	144 20	St. Andrew's Island . . .	5 20	132 16
Radack chain of islands, viz.			Pulo Anna . . .	4 38	132 3
Aour, circular group of 32 islands extending 13 miles N. W. and S. E. anchorage . . .	5 19	171 12	Pulo Mariere . . .	4 19	132 28
Kaven group 33 miles N. W. and S. E.			Lord North's I . . .	3 3	131 20
— Araksheef Island, (largest I.) . . .	8 54	170 49	Ganges Shoal, S. W. P. . .	2 52	131 7
— Southern Island . . .	8 29	171 11	— N. E. P. . .	3 6	131 23
Tahitchagoff, circular group of islands N. W. & S. E. 24 miles, mid- dle . . .	9 6	170 4	Helen's Shoal . . .	2 50	131 41
Rotmanzoff, circular group of 65 islands, E. & W. 30 miles & 10 miles wide inclosing a sea 18 miles wide & 27 miles long . . .			Freewill or St. David's Islands, limits . . .	0 49 1 2	134 17 134 30
— Odia I. eastern; an- chorage . . .	9 28	170 16	Pelew Islands, — Baubellhouap, E. P. . .	7 41	134 55
Legiep or Hayden group 'ilou group, 15 miles long, 5 miles wide . . .	9 51	169 13	— Northernmost, Ky- angle . . .	8 8	134 50
— Krusenstern-Capeni- us I. (northern) . . .	10 27	170 00	— Large Reef, part dry — Southernmost, An- gour . . .	8 18 6 53	134 41 134 21
I. Du Nouvel An . . .	10 8	170 55	Mateletes, N. E. I. . .	8 34	137 45
Kutosoff or Udirick group separated by a chan- nel from a southern group called Souror- off or Tagay, extend- ing N. & S. 25 miles . . .			— Southernmost . . .	8 19	137 45
— Channel . . .	11 11	169 50	Yap or Hunter's I. N. P. — S. P. . .	9 40 9 30	138 8
Group north of Kutosoff — Mille . . .	6 16		Philip Islands . . .	9 6	140 3
— Medjuro . . .	7 13		Thirteen Islands . . .	7 18	141 21
— Arno . . .	7 25		Haweis' Island . . .	7 30	146 28
Bigar, south of Kutosoff . . .	11 40		Strong's Island . . .	5 12	162 58
Pescadores Is. southern . . .	11 00	167 30	Islands . . .	6 28	153 24
— northern . . .	11 20	167 2	Islands . . .	5 47	157 42
Radick chain of islands, extend nearly N. & S. about one degree west of the Radack chain, viz.			Islands . . .	6 9	160 51
Ebon group . . .	5 50	167 15	Islands . . .	6 17	159 12
— Noamureck I. . .	5 30		Hope's Islands . . .	5 15	165 12
Kuli group . . .	6 40		Baring's Islands . . .	6 35	162 13
Helut group . . .	7 30		Palmyra Island . . .	5 49	162 29
Odia group . . .	8 15		Cluster of Islands Ditto . . .	9 38 9 55	161 26
Namou group . . .	9 00		Brown's Range . . .		
— Lital Island . . .	8 55		— Arthur's Island, N. . .	11 43	162 42
— Tebot Island . . .			— Parry's Island, S. . .	11 19	162 52
Quadelon group . . .			Margaret's Island . . .	8 52	166 15
Oudia-Milai group . . .	10 46		Lydia's Island . . .	9 4	166 58
Radogala group . . .	11 00		Catharine's Island . . .	9 14	166 2
Bigini. (northern) . . .		167 15	Arrecife's Island . . .	9 36	161 8
			Muskitto Group, low and dangerous . . .	7 20 7 47	169 23
			Peterson's Island . . .	8 54	166 35
			Chatham Island . . .	9 20	171 20
			Reef . . .	10 00	179 21
			Calvert's Islands . . .	8 48	172 00
			Ibbetson's Islands . . .	8 6	172 8
			Elmore Islands . . .	7 42	168 45
			Mulgrave's Islands . . .	5 54	172 39
			Banham's Island . . .	5 50	109 48
			Cook's Island . . .	1 18	171 57
			Hall's Island . . .	0 54	173 4
			Reef . . .	1 00	179 34
			Pitt's Island . . .	2 54	174 30
			Matthew's Island . . .	1 50	176 10
			Simpson's Island . . .	0 26	175 27
			Macasgil's Islands . . .	6 12	160 53
			St. Bartholomew . . .	15 10	163 48
			Cornwallia or Smyth's Isles . . .	16 46	169 29
			Wake's Island . . .	19 00	166 46
			Lamira, W. Pt. . .	20 24	166 42

TABLE XLVI. Latitudes and Longitudes.

	Lat.		Long.			Lat.		Long.	
	D.	M.	D.	M.		D.	M.	D.	M.
Sandwich Islands.	Gasper Island	16	3N.	177 00E.	Massachusetts Island	22	28N.	177 34	
	Gasper Rico I.	14	42	169 3	Island	24	4	168 00	
	Wake's Rocks	17	48	173 45	Henderson Island	24	6	178 30	
	St. Peter	11	3	179 55W	— another account	24	26		
	Barbados	8	54	178 21	Gardner's Reef	24	11	168 9	
	Kruseestern's Rock	22	15	175 37	Pollard's Island	24	48	168 00	
	Necker Island	23	34	164 32	Allen's Reef	25	09	167 57	
	French Frigate's Shoal	23	45	165 50	Cooper's Island	25	4	131 26	
	Lisiansky's Island	26	3	173 40	Maro's Reef	25	26	170 16	
					Island	25	22	131 26	
	Owhyhee, N. point	20	17	155 58	A Rock	25	30	174 3	
	— E. point	19	34	154 54	Laysan's Island	25	50	171 51	
	— S. point	18	54	155 45	Lucanskey's Island	25	52	173 41	
	— Karakakou Bay	19	28	155 56	Neva Island	26	5	172 25	
	Mowee, E. point	20	50	155 56	Maro's Reef, (dangerous)	26	6	170 24	
	— S. Point	20	34	156 12	Island & Rock	26	24	170 34	
	— W. point	20	54	156 36	Pearl & Hermes group or	27	46	176 15	
	Tahoorowa	20	35	156 33	Clarke's Reef 60 miles				
	Ranai, S. point	20	46	156 52	N. W. and S. E.	27	49	176 6	
	Morotoi, W. point	21	10	157 14	Bunker's Island	28	00	173 30	
	Wonho	21	43	157 58	Island	28	25	178 14	
	Attoi, Whymoa Bay	21	57	159 40	Island	28	54	178 45	
Galapagos Islands.	Tahoora	21	40	160 24	Swift's Island	32	53	119 6	
	Oncheow	21	50	160 15					
	Orechoa	22	2	160 8	Culpepper's Island	1	40	92 00	
	Bird's Island	23	8	161 45	Wenman's Island	1	23	91 44	
	Gardner's Island, discovered 1820	25	3	167 40	Redondo Rock	0	15	91 34	
	Maro's Reef, ditto	25	28	170 20	Abington Island, C. Iberson	0	29	90 43	
					Albemarle I. C Berkeley	0	2	91 31	
	Gallego Island	1	42	104 5	— Christopher's Point	0	50S.	91 25	
	Christmas or Noel I.	1	58	157 32	James I. Harbour	0	12	90 41	
	Sidney or Fanning's I.	3	44	159 23	Charles I. S. P.	1	30	90 33	
	Island	4	30	126 00	Chatham I. N. E. P.	0	45	89 9	
	New-York Island	4	44	160 6	— Stephen's Bay	0	53	89 37	
	Cocos Islands, or Chat-ham Bay	5	27	87 15					
	Palmyra I.	5	48	162 19					
	Island	6	36	166 50					
	Barber's Island	8	50	178 00					
	Reef	10	00	179 24					
	Clipperton's low Island	10	28	109 19					
	A Rock	11	6	154 30					
	Island	11	33	164 00					
	Island	13	9	168 24					
	Shoal	13	32	170 31					
	Shoal	14	30	170 33					
Torres Straits.	Cluster of Islands	16	00	138 00					
		17	00	136 00					
	Island	16	30	163 64					
	Passion Rock	16	56	109 5					
	Cornwallis I.	16	54	169 33					
	New Blada	18	17	114 3					
	Clarion Island	18	21	114 52					
	Island	18	22	155 15					
	Shoal	18	27	170 30					
	Socora Island	18	43	110 10					
	Island	19	15	166 32					
	St. Berto	19	18	109 53					
	Island	19	22	115 15					
	Roca Partida	19	4	111 6					
	Mallon Island	19	23	165 23					
	Cloud's Island	19	46	115 00					
	Copper Island	20	6	131 54					
	Island	21	00	176 34					
	Shaler's Island	22	6	112 14					

XLIX. Islands, Rocks and Shoals, in the SOUTH PACIFIC OCEAN.

	Lat.		Long.	
	D.	M.	D.	M.
New Guinea				
— Middleburg Island	0	20S.	132	162
— Cape of Good Hope	0	20	139	31
— Flat Point	0	46	134	25
— Cape Valshe	8	26		
— Cape Rodney	10	2	147	58
— King William's Cape	6	40	148	11
Torres or Endeavour Straits				
Eastern Fields or Reefs,				
N. E. end	10	2		
— N. W. part	9	59	146	26
Murray's Islands	9	53	144	3
Wamvax or Darnley I.	9	28	143	40
Pandora's Shoals, N. P.	9	55	144	14
— Wreck Reef, S. P.	11	25	144	00
— Portlock's Reef	9	48	144	45
— ent. Torres Straits	9	54	144	42
— Boot Reef	9	59	144	40
Indefatigable's ent. ditto	11	50	144	10
Halfway Island	10	7	143	19
Booby Isls	10	27	141	56
York I. (Mt. Adolphus)	10	37	142	40

TABLE XLVI. Latitudes and Longitudes.

291

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Prince of Wales' group, N. P.	10 00S.	142 12E.	Onaseuse or Hunter's I.	15 31S.	176 11E.
Kangaroo coral reef	13 22	143 47	De Peyster's Islands	8 5	178 17
Providence Islands			Ocean's High Island	0 48	170 49
— Little Providence or			Pleasant Island	0 20	167 10
Danger I.	0 11	135 12	Gardner's Island	1 00	168 40
— N. W. ext. of Shoal			Duff's Group	10 00	166 50
off ditto	0 1	135 8	Ganges' Island	9 44	166 43
Louisiade Isles			Stewart's Island	8 24	163 00
— Cape Deliverance	11 42	154 30	Egmont or Santa Cruz I.		
Stephen's Island	0 21	137 48	— Cape Boscawen	10 55	166 10
Durour's Island	1 17	143 30	Pitt's or Alderney I.	11 50	166 46
Admiralty Islands, {	1 50	146 00	Cherry Island	11 37	170 24
limits	3 10	149 6	Volcano Island	10 39	166 12
Sydney Shoal	3 20	146 50	Mitre Island	11 49	170 42
Active's first Reef (dis-			Barwell Island	12 13	169 07
covered 1811) . . .	3 40	146 53	Pandora's Reef	12 11	172 00
— second reef (ditto)	3 41	146 37	Charlotte Bank	11 45	174 42
New Ireland					
— Cape St. George	4 54	152 59	Sir J. Banks's Island	13 27	167 24
— Carteret's Harb.	4 48	152 46	Espiritu Santo, C. Lie-		
New Hanover W. end	2 25	149 6	burne	15 41	166 57
New Britain			— C. Cumberland	14 39	166 47
— Cape Palliser	4 19	152 10	— Bay St. Philip and		
— Cape Orford	5 40	152 21	St. James	15 10	167 5
— Port Montague	6 12	151 2	— C. Quiros	14 56	167 20
— Cape Ann	6 27	149 33	Loper's Island	15 23	167 58
Cocos Islands	4 30	156 36	Maakelyne's Island	16 32	167 59
Shoals W. of Bougan-			Mallicolo, C. Sandwich	16 28	167 59
ville's Strait . . .	6 11	154 22	— Port Sandwich	16 25	167 53
Bougainville Strait	7 00	155 55	St. Bartholemew's I.	15 42	167 17
Laughlan's Islands, S E.			Aurora Island	15 8	168 17
ext.	9 20	153 42	Table Island	15 38	167 7
Bridgewater Shoal	8 54	156 49	Whitsuntide Island	15 44	168 20
Cape Deception	8 30	156 56	Amabrym Island	16 9	168 13
Cape Nepean	8 51	157 32	Paoon Island	16 30	169 29
Cape Marsh	9 7	158 46	Three Hills	16 59	168 22
Deliverance small Isld's	10 51	162 27	Apae Island	16 46	168 22
Indispensable Strait, S.			Sheppard's Islands	16 58	168 42
ent.	10 15	161 15	Monument	17 14	168 38
Bellona Island	11 6	159 37	Montague Island	17 26	168 32
Bellona Shoal	12 5	159 48	Hinchinbroke Island	17 25	168 38
Pandora and Indispen-			Sandwich Island	17 41	168 33
sable Shoal, N. P.	12 9	160 30	Erromango, Traitor's		
— S. P.	12 46	160 45	Head	18 43	169 20
Well's Shoal	12 20	157 58	Immer Island	19 16	169 45
Port Praslin	7 30	157 51	Ianna, Port Resolution	19 32	169 41
Stewart's Island	8 24	163 00	Erronam	19 39	170 15
Bradley's Shoal	6 45	161 00	Enatum	20 10	170 4
Lord Howe's Group	5 24	159 37	Durand's Reef	22 6	169 2
Hunter's Islands	4 48	157 00	Walpole I.	22 29	169 16
Shank's Island	0 28	163 00	Matthew's or Hunter's		
Blaney's Island	0 39	174 15	Island	22 24	172 15
Dundas Island	0 15	173 58			
Drummond's Island	1 12	176 24	Diana's Bank, about	15 41	150 30
Byron's Island	1 11	177 13	Bougainville's Reefs	15 35	149 00
Hope Island	2 47	176 59	Alert's Reef	15 12	147 51
St. Augustine Island	5 36	176 15	Mellishe's Keys and	17 2	151 49
Sherson's Island	5 56	176 33	Reefs	17 16	156 12
Ellice's Group	8 29	179 6	Bampton Shoal, lim-	19 49	158 2
Mitchell's Group	9 6	179 48	its	19 30	153 45
Flaskett's I.	9 18	179 50	Avon's I.	19 30	158 12
Independence I.	10 25	179 00	Chesterfield Bank	19 53	158 25
Mitchell I.	10 27	179 22	Bellona Shoals	20 55	159 47
Island	10 45	179 35	Booby Shoal	21 2	159 2

TABLE XLVI. Latitudes and Longitudes.

New Caledonia.

New Zealand.

	Lat. D. M.	Long. D. M.
Minerva's Shoal	20 50	159 23 E.
	21 22	159 10
Baring's Shoals	20 40	158 15
— Sandy I.	21 24	158 30
Keen's Reef	21 9	155 49
Mid-day Reef	21 55	154 20
Small low woody Island	18 3	162 51
Moulin Island	18 31	162 52
Reef, about	19 00	162 52
N. W. Point	19 58	163 30
Ballenhea Island.	20 7	164 22
Podyona, N. W. P.	20 6	164 7
Cape Colnet	20 30	164 56
Cape Coronation	22 5	167 8
Queen Charlotte's Fore-land	22 15	167 13
Ile of Pines	22 42	167 34
Botany Island	22 27	167 17
Prince of Wales Fore-land, S. P.	22 30	166 50
Port St. Vincent	22 00	165 55
Loyalty Island	20 54	166 30
Wreck Reef and Sand Bank	22 11	155 19
Cato's Bank	23 6	155 23
Reef	23 40	160 14
Reef	23 43	164 14
Ray's Island	25 00	166 21
Reef	26 4	160 00
	26 12	
Sir C. Middleton's Is.	25 13	160 31
Middleton's Shoals	24 14	159 53
Elizabeth Reef	30 5	159 00
Island	31 14	160 37
Lord Howe's I.	31 26	159 00
Norfolk I. (Mt. Pitt)	29 2	168 10
Rosavetta Reef	30 30	173 28
North Cape	34 27	173 4
Cape Brun	35 10	175 00
Cape Colville	36 24	175 48
Mercury Bay	30 48	176 6
Cape East	37 44	178 58
Olaga Bay	38 22	178 35
Table Cape	39 6	178 2
Cape Kilmappera	39 43	177 16
Cape Furluggain	40 32	176 49
"Banks" I. E. end	43 43	173 00
Cape Saunders	45 37	170 16
Moloneux Harbour	46 8	169 41
The Snares	48 6	160 20
Onight's Island	48 15	166 44
Cape South	47 17	167 16
South West Bay	46 30	167 25
Solander's Island	46 28	166 33
West Cape	45 56	166 6
Dusky Bay	45 40	166 16
Open Bay	43 51	164 43
Cape Foulweather	41 58	171 30
Cape Farewell	40 40	173 18
Queen Charlotte's Sound	41 5	174 40
Cape Campbell	41 34	174 56
Cape Collier	41 24	175 41
Cape Egmont	39 23	174 12
Great Island	38 5	175 5

Friendly Islands.

Society Islands.

	Lat. D. M.	Long. D. M.
Marquarie's Island	54 42 S.	159 45 E.
The Judge and his clerk	54 10	160 7
The Bishop & his clerk	55 11	159 57
Auckland's Group	50 44	166 00
Campbell's I-land	52 32	169 30
Bounty Islands	47 32	179 2
Antipodes Island	49 35	179 2
Chatham Island, C.		
Young	13 43	176 58
Cornwallis Islands	44 36	175 27
Macleay Island	30 8	179 00
Sunday Island	29 12	178 13
Vasques	25 40	174 56
	23 59	178 20
Nicholson's Shoals	23 37	171 52
	20 6	168 36
Rotumah or Grenville's Island	12 29	176 57
Solitary Island	10 40	176 00
D. of Clarence's I.	9 9	171 31
D. of York's I.	8 33	172 4
Quiros Island	10 40	170 00
Jesus Island	6 46	166 00
Laticus I.	11 42	162 00
Suwarrow's Islands	13 6	163 23
	13 15	163 31
Wallis Island	13 22	176 16
Proby's Island	15 53	175 51
Gardner's Island	17 57	175 17
Keppel's Island	15 53	174 12
Boacawen's Island	15 50	174 8
Navigator's Islands,		
— Opoun, E. P.	14 9	169 2
— Leone, S. P.	14 8	169 16
— Tanfoue, E. P.	14 5	169 18
— Maoune, E. P.	14 17	170 3
— Oyolava, E. P.	14 3	171 7
— Olataclah	14 30	170 41
Calmanse, N. P.	13 45	171 51
Islet Plat	13 51	171 48
Amargura	18 00	174 30
Vavaoo (Howe's) Is.	18 50	174 00
Lati or Bickerton I.	18 52	174 48
Savage Island	19 2	169 30
Uofoa	19 46	175 6
Haaaho	19 41	174 15
Bouhee	19 34	174 29
Annamoka	20 14	174 50
Hounga-happee	20 36	175 17
Tongataboo,		
— Van Dieman's Road	21 6	175 5
Koon, E. P.	21 24	174 45
Pylstaart's Island	22 22	175 41
Pearl & Herme's Reef	27 46	176 00
King George's Reef	19 56	167 30
Palmerston Island	18 00	168 57
Whytootacke	18 56	169 45
Hervay's Island	19 17	158 48
Wateoo Island	20 1	168 15
Maria I.	21 45	155 10
Mangeca Island	21 57	158 7
Roxburgh Islands	21 36	159 40
Scilly Island	16 30	155 10
Lord Howe's I.	16 46	154 6
Maurora Island	16 26	160 33

TABLE XLVI. Latitudes and Longitudes.

293

	Lat	Long.		Lat	Long.
	D. M.	D. M.		D. M.	D. M.
Society Islands.					
Bolabola Island . . .	16 32S.	151 52W	Onateaya Island . . .	9 58S.	138 51W
Mietea . . .	16 45	151 31	Magdalena Island . . .	10 25	138 49
— Ohameneno harb. . .	16 45	151 35			
Huabeine, Owharre Bay . .	16 43	151 8	Bunker's Shoal . . .	0 17	160 40
Sir C. Sander's I. . .	17 25	150 58	Marcus Island . . .	0 26	159 50
Eimeo (Taloo harbour) . .	17 30	150 00	Island . . .	1 5	158 54
Tethuroa . . .	17 1	149 36	Brock's Island . . .	1 13	159 30
Atacite, Point Venus . .	17 29	149 36	Island . . .	3 32	173 45
— Oaitipaha Bay . . .	17 46	149 14	Hero Island . . .	5 40	155 55
Danaburg or Mitea . . .	17 52	149 6	Island . . .	6 39	166 18
			A Rock . . .	7 51	139 54
Pr. of Wales I. N. P. . .	14 58	147 50	Pennryhn's Island . . .	9 1	157 35
Calliser's Island . . .	15 38	146 30	Tienhoven I. . .	10 5	156 57
Chain Island . . .	17 25	143 30	Groningue I. . .	10 5	156 50
Gloucester Island . . .	20 31	145 54	Reisen's Island . . .	10 11	160 49
Obethra . . .	22 27	150 49	Humphrey's I. . .	10 27	160 55
Remitara I. . .	22 43	152 00	A Reef . . .	10 46	166 6
Toobouai . . .	23 25	149 20	Pescado I. . .	10 33	159 25
High Island . . .	23 42	148 3	Roggewien's I. . .	10 51	156 7
Byron's Islands . . .			Tiburones I. . .	10 58	143 00
— Taoukaa Island . . .	14 30	145 9	Flint Island . . .	11 28	162 6
Disappointment Islands . .	14 7	141 22	Bauman's Islands . . .	11 52	155 12
Adventure Island . . .	17 7	144 22	Spiridoff Island . . .	14 41	144 59
Furneaux Island . . .	17 11	143 7	— Perhaps Isl. Oua . .	14 37	146 19
Resolution Island . . .	17 23	141 45	Ile de Chiens . . .	14 50	138 47
Island . . .	16 00	139 00	Ile Romanzoff . . .	14 57	144 28
Island . . .	17 00	138 00			
Bird Island . . .	17 49	142 43	Iles de Kru-		
Bow Island . . .	18 17	140 43	sestern exten-		
Pr. Henry's Island . . .	19 00	141 22	ding N. N. E. } centre	15 00	142 41
Cumberland I. . .	19 18	140 52	and S. S. W. }		
Gloucester Island . . .	19 11	140 20	15 miles		
Queen Charlotte's I. . .	19 18	139 20	Chaine du Rurick, N.		
Whitunday Island . . .	19 26	138 12	E. P. . .	15 11	
Lagoon Island . . .	19 48	138 33	— E. P. . .	15 20	146 30
			— W. P. . .	15 20	
Oanaburg Island . . .	22 8	140 37	Dageraad Island . . .	15 45	146 56
Bligh's Lagoon, I. . .	21 43	140 30	Dean, or Prince		
Carysfoot Island . . .	20 49	139 33	of Wales, or } W.P.	15 00	146 22
Lord Hood's Island . . .	21 31	135 32	Oanna Island } E. P.	15 16	147 12
Gambier's Island . . .	22 55	135 00	Island . . .	16 00	139 00
Crescent Island . . .	23 12	134 32	Island . . .	17 00	138 00
St. Juan Baptista . . .	24 26	135 6	Island . . .	20 00	167 50
Pitcairn's Island . . .	25 4	130 25	Elizabeth Island . . .	21 6	178 36
Oparo Island . . .	27 36	144 11	Eunice Island . . .	21 8	178 47
			Armstrong's Island . .	21 21	161 4
Nukahiwa I. (Federal)			Anderson's Island (or		
— Port Tochitschagoff . .	9 57	139 42	Elizabeth I.) . . .	24 24	128 11
— Port Anna Maria, ent. .	8 57	139 40	Ducie's Island . . .	24 40	124 40
— Cape Martin S. E. P. . .	8 57	139 32	Island . . .	25 13	130 28
— South Point . . .	8 59	139 44	St. Felix Islands N. P.	26 20	79 47
— N. W. point . . .	9 53	139 49	— W. P. . .	26 17	80 4
Uabuga I. (Washing-			Gray's Island . . .	26 24	92 24
ton I.) W. P. . .	8 58	139 13	Sales y Gomez . . .	26 36	105 34
Uapoa I. (Adams) . . .	9 21	139 39	Easter Island . . .	27 8	109 40
Level I. (Lincoln) . . .	9 29		Island . . .	28 6	95 12
Mottauity Islands			Group of Islands . . .	31 3	129 24
(Franklin) . . .	8 37	140 20	Masafuero . . .	33 45	80 38
Hiau I. (Knox, Roberts)	7 59	140 13	Juan Fernandez S.W.P.	33 45	79 6
Small Sandy Island . . .	7 57	140 3	— E. P. . .	33 41	78 53
Fatturahu I. (Hancock)	7 50	140 6			
			NEW SOUTH SHET-		
Hood's Island . . .	9 26	138 52	LAND.		
Ohevahon . . .	9 41	139 2	Clarence Island, Floyd's		
Obitahoo, Resolution			Promontory . . .	60 57	54 6
Island . . .	9 55	139 9	— Cape Bowles . . .	61 20	54 8
			Cornwallis Island . .	61 00	54 22

TABLE XLVI. Latitudes and Longitudes.

	Lat. D. M.	Long. D. M.		Lat. D. M.	Long. D. M.
Seal Islands .	61 00S.	55 32W	Ditto (another ac-		
Cape Valentine .	61 3	54 40	count) .	62 42S.	62 20W
Sarah Island .	61 22	55 30	Ditto the harbour		
Obrien's Islands .	61 28	56 35	(by another person)	62 55	63 5
Bridgeman's Islands .	62 00	57 12	New Plymouth .	62 45	61 37
Cape Melville .	62 00	57 46	Monroe's Island, Presi-		
Sheriff Cape .	62 28	60 57	dent's Bay .	62 46	62 20
Ditto (another ac-			Castle Rock (west of		
count) .	62 21	61 47	Monroe's I.) .	62 50	62 30
Yankee Straits .	62 30	60 22	Mount Pisgah .	63 00	63 00
Ragged Island .	62 40	62 10	Ditto (another ac'nt.	62 57	63 40

Note to page 279, Table XLVI. line 1.

I have considered the *Essex Shoal* to be the same as the *Fairlie Rock*, and have given its latitude and longitude as in Horsburgh's Directory, namely 3° 27' S. 107° 2' E. The place assigned by Captain Orne, of the *Essex*, is 3° 36' S. 107° 00' E. differing nine miles in latitude; and as it is possible that the rocks may not be the same, I have now given Captain Orne's estimate, made from a meridian observation two hours after striking on the shoal, June 26, 1804. He described it as "a small rock or coral patch, seen by the man at the mast head an instant before she struck; but there was no appearance of a breaker, though the breeze was fresh, and a short sea running. In the act of wearing ship, she struck rather on the side of the rock, which reduced her velocity from 8 to 2½ knots; after rubbing a few seconds, she fell off into deeper water (8 fathoms) without any material damage."

TABLE XLVII.

285

TABLE,

Showing the *TIMES* of *HIGH WATER* at the *fall and change* of the *Moon*, at the *principal Ports and Harbours of the World*, with the *vertical rise of the Tide in feet*.

PLACES.	SITUATION	TIME.	R.	PLACES.	SITUATION.	TIME.	R.
A		H. M. FT.				H. M. FT.	
Abbeville	France	10.30		Bolt Head	England	5.55	20
Aberdeen	Scotland	12.45		Bombay	India	11.15	
Aberystwith	Wales	7.30	13	Bombay Offing	India	12.0	
Achill Head	Ireland	5.00		Borkum Island	Holland	11.0	
Air Point	Isle of Man	10.30		Boston	England	6.45	
Aix	France	11.0		Boston	America	11.30	11
Alban's Head (St.)	England	7.30		Botany Bay	New Holland	8.0	
Amazon River	America	6.0		Boulogne	France	10.45	
Ambleuse	France	11.0		Bourdeaux	France	3.0	
Ameland Island	North Sea	10.00		Brassa Sound	Shetland	10.0	8
Amelia Harbour	America	8.30		Bray Head	Ireland	3.30	
Amelwick Point	Anglesea	10.30	24	Bremen	Germany	6.0	
Amsterdam	Holland	3.0		Brest	France	3.45	18
Amsterdam Island	Pacific Ocean	8.30		Brudgewater	England	6.45	22
Andrew's Bay, St.	Scotland	2.15		Bridport	England	6.45	
Angra Bay	Terciera	2.20	8	Brighton	England	10.4	16
Anholt Island	Cattégat	12.0		Brighton	England	6.45	
Ann (Cape)	America	11.30	11	Broad Bay	America	10.45	9
Annapolis	America	11.0		Broad Haven	Ireland	6.0	
Anticosta I. W. end	America	3.30		Burnt Island	Scotland	2.30	14
Antwerp	France	6.0		Button's Islands	Hudson's Bay	6.50	
Annamocka	Pacific Ocean	6.0		C			
Archangel	Russia	6.0		Cádiz	Spain	3.0	
Arklow	Ireland	8.15		Caen	France	9.0	
Artan Island	Scotland	11.15	9	Caernarvon	Wales	9.0	22
Arundel	England	9.20	16	Calais	France	11.30	18
Augustine, (St.)	America	7.30		Caldy Island	Wales	6.0	34
Augustine's Bay St.	Madagascar	2.15		Calf of Man	St George's Ch.	10.30	
Avranches	France	6.00		Campbell (Port)	America	9.0	
B				Canary Island	Atlantic Ocean	3.0	
Babelmandel Str.	Red Sea	12.0		Canso (Cape)	America	11.30	
Balisore	India	9.45	12	Cantire (Mull of)	Scotland	10.30	5
Ballingakellings B.	Ireland	3.15		Capricorn (Cape)	New Holland	8.0	7
Bally Castle	Ireland	9.0		Cardiff	Wales	6.0	
Bally Shannon	Ireland	6.45		Cardigan Bar	Wales	7.0	
Baltimore	Ireland	2.0		Carlingford	Ireland	10.0	14
Barni	Scotland	11.30		Carlisle	England	12.0	
Bantry Bay	Ireland	3.30		Carmarthen	Wales	6.30	24
Bardsey Island	Wales	9.15		Carrickfergus	Ireland	10.30	8
Barileur Cape	France	7.30		Caskets	Eng. Channel	8.0	28
Barmouth	Wales	8.0	13	Catherine's Pt. St.	Isle of Wight	9.0	
Barstable Bay	England	11.50	26	Catness	White Sea	5.15	
Baudsey Cliff	England	10.30		Cayeane	S. America	6.0	
Bayonne	France	11.30		Charente Riv. ent.	France	4.0	20
Beachy (on shore)	England	9.45	20	Charles (Cape)	America	7.45	
Beachy, Offing	England	11.0		Charleston Bar	America	7.15	6
Bear Island	Hudson's Bay	12.0		Chatham	England	1.0	
Beaumaris	Wales	10.15	24	Chpstow	England	7.30	
Beet's Head, St.	England	11.15		Cherbourg	France	8.30	
Belfast	Ireland	10.30		Chester Bar	England	11.0	26
Belle Isle	Bay of Biscay	3.0		Chichester Harb.	England	11.30	19
Bembridge Point	Isle of Wight	11.40		Christmas Sound	S. America	2.30	
Bergen	Norway	1.30		Churchill (Cape)	Hudson's Bay	7.20	
Bermuda Island	Atlantic Ocean	7.0	5	Cleat (Cape)	Ireland	3.00	
Berwick	England	2.15	16	Cod (Cape)	America	11.30	64
Biscay	Spain	3.45		Condore Pulo	China Sea	4.15	
Bilboa	Spain	3.45		Conway	Wales	10.15	24
Blakeney	England	6.0		Copeland Island	Ireland	10.30	
Blanco (Cape)	Ireland	9.45		Coringo Bay	Ireland	9.15	
Blasketa	Ireland	3.40		Coquet Island	England	2.45	13
Block Island	America	7.37	5	Coruwall (Cape)	England	4.30	22
Bondor (Cape)	Africa	12.0		Cornwallis (Port)	Pr. of Wales' I.	1.30	10

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME.	R.	PLACES.	SITUATION.	TIME.	R.
		H. M. FT.				H. M. FT.	
Cork Harbour, en.	Ireland	4.30	18	Fly or Vlie Gatway	Holland	7.15	
Corunna	Spain	3.0		Fly or Vlie Road	Holland	7.30	
Coutance	France	6.0		Foreland (North)	England	11.15	10
Cowes	Isle of Wight	10.15	15	Foreland (South)	England	11.45	15
Crocotoa Island	Str. of Sunda	7.0	3	Formby Point	England	11.00	30
Cromartie	Scotland	11.30	14	Fort St. John	Newfoundland	9.0	
Cromer	England	6.45	16	Fox Island	America	10.45	
Crookhaven	Ireland	11.30		Fowey	England	5.30	10
Cross Island	White Sea	4.15		Funchal	Madeira	11.30	2
Cuxhaven	Germany	1.0		G			
D				Gallicia (Coast of)	Spain	3.0	
Dartmouth	England	6.10	20	Galloper	Thames River	12.45	
David's Head, (St.)	Wales	6.0		Galloway Bay	Ireland	4.30	
Deadman's Pt.	England	6.30		Galloway, Mull of	Scotland	11.15	
Deal	England	11.0	15	Gambia R. ent.	Africa	10.15	
Dee (River)	Scotland	11.0		Gay Head	America	7.37	7
Delaware R. ent.	America	9.0		George's River	America	10.45	9
Diamond Point	India	2.15		Georgetown Bar	America	7.0	
Dieppe	France	10.30	18	Goa	India	4.30	
Dingle Bay	Ireland	3.30		Good Hope, (Cape)	Africa	8.0	
Donnegal	Ireland	6.30		Good Hope, Town	Africa	2.30	
Dover	England	11.6	14	Goree Gatway	North Sea	1.30	
Douglas	Isle of Man	10.30	21	Gouldsbrough	America	11.0	12
Downs	England	11.0	15	Granville	France	7.30	
Drogheda	Ireland	10.45		Gravelines	France	11.45	18
Drontheim	Norway	2.15		Gravesend	England	1.30	16
Dublin	Ireland	9.45	12	Grizness, (Cape)	France	11.0	
Dudgeon Lights	North Sea	6.0		H			
Dunbar	Scotland	2.0		Hazerlem	Holland	9.0	
Duncansbay Head	Scotland	10.0		Hague La, (Cape)	France	8.45	
Dundalk Bay	Ireland	10.45		Halifax	Nova Scotia	7.30	9
Dundedy Head	Ireland	4.0	11	Hamburgh	Germany	6.0	
Dundee	Scotland	2.15		Hartland Point	England	6.0	
Dungarvon	Ireland	4.30		Hartlepool	England	3.45	
Dungeness	England	10.51	24	Harwich	England	11.30	14
Dunkirk	France	11.45	12	Hasborough Gatt	England	6.30	
Dunnose	Isle of Wight	9.15		Hastings	England	10.30	
Dursey Island	Ireland	3.30		Hatteras, (Cape)	America	9.0	
E				Havre de Grace	France	9.00	
Eastern Brace	Bay of Bengal	9.45		Helena, St.	Atlantic Ocean	2.15	
Eddystone	Eng. Channel	5.50	18	Helena, St.	Isle of Wight	11.45	10
Edinburgh	Scotland	2.30		Helvoetsluis	Holland	1.30	
Elbe R. (red buoy)	North Sea	11.0		Henlopen, (Cape)	America	8.45	5
Elizabeth Town Pt.	America	8.54	5	Henry, (Cape)	America	7.40	
Embsen	Germany	12.0		Holyhead Bay	Wales	10.00	24
Exmouth Bar	England	6.25	14	Holy I. Harbour	England	2.30	15
Exuma Bar	Bahamas	6.35		Honfleur	France	9.30	
Eyder River	Germany	12.0		Hull	England	6.0	16
Eyemouth Harb.	Scotland	2.15		Humber R. ent.	England	5.15	10
F				Hurst Castle	England	9.30	
Fair Head	Ireland	9.0		I			
Falmouth	England	5.30	18	Ice Cove	Hudson's Bay	10.0	
Fayal Road	Azores	2.20	42	Ipswich	England	12.0	
Fear (Cape)	America	8.0		Ireland, W. Coast	Atl. Ocean	5.30	
Fecamp	France	11.30		Ireland, S. Coast	Atl. Ocean	3.0	
Ferrol	Spain	3.0		Isle de Dieu	France	3.0	
Ferriters	Ireland	3.30		Isle of Man, S. side	St. George's St.	10.20	
Fifeness	Scotland	2.0		Ives, (St.)	England	5.15	20
Filey	England	4.30		Jackson, Port	New Holland	8.15	6
Finsterre (Cape)	Spain	3.0		Janeiro Rio	S. America	4.30	
Finmark	Lapland	2.15		Johns, (St.)	Newfoundland	6.0	
Fisguard Bay	Wales	6.30		Jutland Coast	Denmark	12.0	
Flamboro' Head	England	4.0		K			
Florida Keys	America	8.50		Kedgerie	India	11.30	
Flushing	Holland	1.0		Kenmore River	Ireland	3.30	

TABLE XLVII.

297

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME.	PLACES.	SITUATION.	TIME.
		H. M. FT.			H. M. FT.
Kennebeck	America	10 45 9	North Cape	Lapland	3. 0
Kentish Knock	R. Thames	11.45	O		
Killybegs	Ireland	6.45	Olonne	France	3 30
King's Channel	River Thames	12.30	Oporto	Portugal	3.15
King's Road	Bristol Chan.	6.45	Orfordness	England	10 30 11
Kinsale	Ireland	4. 0	Orkney Islands	North Sea	10.30 8
Kinnaird's Head	Scotland	12. 0	Orm's Head	Wales	10.15
L			Ortega (Cape)	Spain	3. 0
Lambaness	Shetland	9.30	Ostend	France	12.30 1
Lancaster	England	11.15	Owers	Eng. Channel	9.36 15
Land's end	England	4 30	P		
Leith Pier	Scotland	2.26 15	Padstow	England	5.45 27
Lemon and Ower	North Sea	7. 0	Passamaquoddy R.	America	11 30 23
Lerwick	Shetland	9.45	Passier Roads	Borneo	5 0 9
Lewis Islands	Scotland	6. 0	Penmarks	France	3. 5
Lewis (Butt of)	Scotland	6. 0	Penobscot River	America	10. 15 10
Limerick	Ireland	6.30 15	Pentland Frith	Scotland	10 30 8
Lisbon	Portugal	3. 0	Penzance	England	5 0 9
Liverpool	England	11. 0 37	Peter Head	Scotland	12 0
Lizard	England	5. 0	Plymouth Sound	England	6 15
Lough Swilly	Ireland	6.30	Plymouth	America	11 30 6
Loire River	France	3. 0	Pol de Leon (St.)	France	5.15
London	England	2.46 15	Poule	England	9 0 7
Londonderry	Ireland	6. 0	Port Glasgow	Scotland	11 45
Long Sand Head	River Thames	11 30	Port Hood	Cape Breton	7.30 5
Longships	England	4.30	Port Howe	Nova Scotia	8.30 4
Lookout (Cape)	America	9. 0 7	Port Jackson	Nova Scotia	8 0
Loo Head	England	4.15	Portland Bill	England	7 15 8
L'Orient	France	4 0	Portland Race	England	9.15 7
Lundy Island	Bristol Chan.	5.45 30	Portland	America	10 45 9
Lyons Regis	England	7. 5	Port Louis	France	4 0 15
Lynn Deep	England	6.30	Porto Praya	C. Verd Isles	11. 0
M			Port Roseway	Nova Scotia	8.15 8
Machias	America	11. 0 12	Port Royal Island	N. America	8.15
Madeira	Atl. Ocean	11.30 7	Portsmouth Harb.	England	11 36 15
Malacca Roads	India	10.30	Portsmouth	America	11.15 10
Mario St.	France	6 30	Portugal, Coast of	Europe	3. 0
Marblehead	America	11.30 11	Pulo Pinang	India	1.30 10
Margate Road	River Thames	11 45 16	Q		
Martin Vaz	Atl. Ocean	3.45	Quebec	Canada	8. 0
Marya, St.	Scilly Islands	4.40	Queda Roads	India	10 0 6
May, Cape	America	8.45	R		
Melford Haven	England	6. 0	Rachlin's Island	Ireland	9. 0
Mizen-head	Ireland	3.15	Ram Head	England	5.45
Montrose	Scotland	1 30	Ramsey	Iste of Man	10 30
Morocco Coast	Africa	2.15	Ramsgate	England	11 0
Mount's Bay	England	5. 0 19	Rhe Island	Bay of Biscay	3. 0
Mount Desert	America	11. 0 19	Rhode-Island	America	6 45
N			Rio Janeiro	S. America	4.30
Nagasaki	Japan	7.53	Robin Hood's Bay	England	3 45
Nantz	France	4. 0	Rochefort	France	3. 0
Nantz River ent.	France	3. 0	Rochelle	France	3.45
Nassau	N. Providence	7.30	Rochester	England	1. 0
Natal Rivier	Africa	10. 0 12	Rodrigues Island	Indian Ocean	12 45 6
Needles	Isle of Wight	9. 0	Roman (Cape)	America	8. 0
Newcastle	England	4 0	Roseneau	Orkney	10.30
New-Bedford	America	7.37	Rotterdam	England	3.31 7
Newburyport	America	11.15 10	S		
New-Haven	America	10 16	Sable (Cape)	Nova Scotia	8. 0
New-London	America	8.54	Sable Island	America	8.30
Newport	Wales	6.45	Salem	America	11.30 11
New-York	America	8 54	Salvador, St.	S. America	3.45
Noatka Sound	North America	12.20	Sandwich	England	11. 0
Nore Light	River Thames	12.1 14	Sandwich Bay	Nova Scotia	9. 0 8
North Berwick	Scotland	2 0			

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME.	R.	PLACES.	SITUATION.	TIME.	R.
		H. M. FT.				H. M. FT.	
Sandy Hook	New-Jersey	6.37	5	Telling (Cape)	Ireland	6. 0	
Scarborough	England	8.30	13	Terciera	Azores	11.45	8
Scaw	Denmark	12. 0	15	Texel, (ent. of)	Holland	6.45	
Scilly Islands	Eng. Channel	4.40	18	Texel Road	Holland	7.45	
Seal Islands	Bay of Fundy	9.45		Thames, R. mouth	England	12. 0	
Seine River	France	9. 0		Tinmouth	England	3. 0	13
Selsea Bill	England	9.36	16	Todhead	Scotland	12.45	
Selsea Harbour	England	11.15	15	Torbay	England	6.10	20
Senegal R. ent.	Africa	11. 3		Tory Island	Ireland	6. 0	
Seven Islands	Lapland	9. 0	15	Townsend	America	10.45	9
Shannon R. ent.	Ireland	3.45	12	Tuskar Rock	Ireland	7. 0	
Sheerness	England	12. 0	15	Tyta Roads	River Canton	10. 0	0
Sheepshead	America	10.45	9	U			
Shetland I. S. end	North Sea	10.30	6	Ushant (within)	France	3.45	
Shields	England	3. 0	13	Ushant (without in			
Shoreham	England	9.21	16	the offing)	France	4.30	
Sierra Leone	Guinea	8.15		V			
Simon's Bar (St.)	America	7.30		Vannes	France	4.30	
Skerries	Wales	10. 0		Vincent (Cape St.)	Spain	2.30	
Skerries	Scotland	5.30		W			
Sky Island	Scotland	6. 0		Wardhuys	Lapland	4. 0	
Sligo	Ireland	6.45		Watchet	Bristol Chan.	6.45	
Slyne	Ireland	5.15		Waterford Harb.	Ireland	5.30	13
Smalls	Wales	5.50		Weser, River ent.	Germany	12. 0	
Somme River	France	10.30		Western Braco	Bay of Bengal	9.36	
Southampton	England	11.45	18	Wexford Harbour	Ireland	7.30	
Southwold	England	9. 0		Weymouth	England	6.15	7
Spain (N.coast of)	Bay of Biscay	3. 0		Whitby	England	3.45	13
Spurn Point	England	5.15	20	Whitehaven	England	11.15	
Start Point	England	5.55	20	Wicklow	Ireland	9. 0	
Stockton	England	4.30		Winterton	England	8.15	10
Stonehaven	Scotland	1. 0		Woolwich	England	2.15	13
Stromness	Orkneys	10.30		Wrath (Cape)	Scotland	7. 0	
Sunbury	N. America	9. ■		Y			
Sunderland	England	2.45	12	Yarmouth Roads	England	8.45	
Swansey	Wales	6. 0	30	Yarmouth	Isle of Wight	9.30	13
Sweetnose	Lapland	12. 0	16	Yorkshire Coast	England	4.30	
T				Youghall	Ireland	4.30	13
Tees River	England	3.30	16				

APPENDIX,

CONTAINING METHODS OF DETERMINING THE LONGITUDE BY OBSERVATIONS OF ECLIPSES, OCCULTATIONS, &c.

THE longitude of a place may be determined in a very accurate manner, by observing the beginning or end of a solar eclipse, or occultation of a fixed star by the moon, or the difference between the times that the moon and a known fixed star pass the meridian. These observations, when made on land with a good telescope and well regulated time-keeper, furnish by far the most accurate method of determining the longitude, and when made on board a ship without a telescope, will in general give it to a greater degree of accuracy than any other method: For this reason, it was thought proper to insert in this Appendix the usual rules of calculating such observations, by means of the Nautical Almanac. The first thing to be taken notice of, is the method of determining the longitude, latitude, &c. of the moon or other object, having regard to the unequal velocity between the times for which these quantities are given in the Nautical Almanac. This calculation is rendered much more simple by making use of the signs + and —, and performing addition and subtraction as in the introductory rules of Algebra; and as it is possible that these rules may not be familiar to some readers of this work, it was thought proper to prefix an explanation, as far as will be necessary, in the present problems.

Quantities *without a sign*, or with the sign + prefixed, are called *positive or affirmative*, as 7 or + 7; and those to which the sign — is prefixed, are called *negative*, as — 7. Addition of quantities having the same sign, that is, all affirmative or all negative, is performed by adding them as in common arithmetic, and prefixing the common sign. Thus the sum of + 4 and + 3 is + 7. The sum of — 4 — 3 and — 5 is — 12. When the quantities have not the same sign, the positive quantities must be added into one sum, and the negative into another, as above; the difference of these two sums, with the sign of the greater sum prefixed, will be the sum of the proposed quantities. Thus the sum of + 14, — 7, + 5, and — 2, is found by adding + 14 + 5, whose sum is + 19; and then — 7 and — 2, whose sum is — 9; the difference of 19 and 9 is 10, to which must be prefixed the sign of the greater number 19, which is +, so that the sought sum is + 10. The following examples will illustrate these rules.

Add + 4 + 3 + 7 — 2	Add + 4' 10" + 2 5	Add — 4' 10" — 2 5	Add — 4' 10" + 2 5	Add + 1 — 1	Add + 8' 0" — 2 15 + 4 15 — 3 7
Sum + 12	Sum + 6 15	Sum — 6 15	Sum — 2 5	Sum 0	Sum + 4 51

Subtraction is performed by changing the sign of the number to be subtracted from + to —, or from — to +; and then adding the numbers by the preceding rule. Thus to subtract + 3 from + 7 the sign of + 3 must be changed, and the numbers — 3 and + 7 added together as in algebra, which by the preceding rule gives + 4; and if it were required to subtract — 3 from 7, the sign of — 3 must be changed, and + 3, + 7 added together. The sum + 10 represents the sought difference. It is not usual to make an actual change of the sign in any proposed question, it being sufficient to suppose the number to be subtracted to have a different sign from that prefixed to it, and to perform the operation accordingly. To illustrate this, the following examples are added.

Fro. + 4' 10" Sub. + 2 5	Fro. + 4' 10" Sub. — 2 5	Fro. — 4' 10" Sub. — 2 5	Fro. — 4' 10" Sub. + 2 5	Fro. + 1 Sub. — 1	Fro. — 1 Sub. — 1	Fro. + 1 Sub. + 1
Re. + 2 5	Re. + 6 15	Re. — 2 5	Re. — 6 15	Re. + 2	Re. 0	Re. 0
From 108 Sub. 201	From — 108 Sub. — 201	From 108 Sub. — 201	From — 108 Sub. 201	From — 108 Sub. 201	From — 201 Sub. 108	
Rem. — 93	Rem. + 93	Rem. + 309	Rem. — 309	Rem. — 309	Rem. — 309	

Observing that when no sign is annexed to a quantity, the sign + is always understood to be prefixed.

PROBLEM I.

To find the longitude, latitude, &c. of the moon at any given time at Greenwich, having regard to the unequal velocity between the times marked in the Nautical Almanac. The intervals of these times being 12 hours.

RULE.

Take from the Nautical Almanac the two longitudes, latitudes, &c. next preceding the given time at Greenwich, and the two immediately following it, and set them down in succession below each other, prefixing the sign + to the southern latitudes or declinations, and the sign — to the northern. Subtract each of these quantities from the following for the first differences, and call the middle term arch A; subtract O o (Tab.)

each first difference from the following for the *second differences*, and take the half sum or mean of them, which call the arch B, noting the signs of the quantities as in algebra.

Find the difference between the given time and the second time taken from the Nautical Almanac, which call T, then to its logarithm add the log. of A and the constant logarithm 5.36452, the sum rejecting 10 in the index, will be the logarithm of the *proportional part*,* to which prefix the sign of the arch A; observing to express all these quantities in seconds.

Enter Table XLV. with the arch B at the top and the time T at the side,† opposite to this will be the correction of second differences, to which prefix a *different sign* from that of the arch B, and place it under the proportional part found above, and the second quantity taken from the Nautical Almanac, and connect these three quantities together as in addition in Algebra; the sum will be the sought longitude, latitude, &c. The latitude or declination being *south* if it has the sign +; *north* if it has the sign —.

EXAMPLE I.

Required the longitudes and latitudes of the moon, December 12, 1808, at 15h. 45. 29' and 17h. 1m. 29" app. time by astronomical computation at Greenwich, which correspond to the immersion and emersion of Spica, calculated in Problem VII.

1808. Dec.	D long. N. A.	1st. diff.	2d. diff.	D lat. S.	1st. diff.	2d. diff.
D	s ° ' "	° ' "	' "	° ' "	' "	' "
12 noon	6 10 45 20	7 6 16		+ 2 40 58	— 34 21	
12 midn.	6 17 51 36	A 7 11 18	+ 5 2	+ 2 6 37	A — 36 45	— 32
13 noon	6 25 2 54	7 16 5	+ 4 47	+ 1 29 52	— 38 34	— 16
13 midn.	7 2 18 59		B = + 4 54 5	+ 0 51 18		B = — 28

IMMERSION.

T = 3h. 48' 29" = 13709"	Constant 5.36452	log. 4.13701	..... 5.36452
A = 7 11 18 = 25878	log. 4.41293	..... 4.13701	A = — 36' 45" = — 2205" log. 3.34341
+ 2 16 52.2 = 8212.2	log. 3.91446	..... 2.24484	— 11 59.7 = — 699.7 log. 2.84484
+ 6 17 51 36 Second longitude.			+ 2 6 37 Second latitude.
— 31.9 Tab. XLV. B = 4' 54".5			+ 13.7 Tab. XLV. B = — 2' 6".5
6 20 7 56.3 D's longitude.			+ 1.55 11.0 D's latitude south.

EMERSION.

T = 5h. 1' 29" = 18089"	Constant 5.36452	log. 4.25742	..... 5.36452
A = 7 11 18 = 25878	log. 4.41293	..... 4.25742	A = — 36' 45" = — 2205' log. 3.34341
+ 3 0 36.0 = 10836	log. 4.03487	..... 2.98895	— 15' 23" 3 = — 923.3 log. 2.98895
+ 6 17 51 36 Second longitude.			+ 2 6 37 Second latitude.
— 35.9 Table XLV. B = 4' 54".5			+ 15.4 Tab. XLV. B = — 2' 6".5
6 20 51 36.1 D's longitude.			+ 1 51 29.1 D's latitude south.

These quantities are made use of in Problem VII.

EXAMPLE II.

Required the longitudes and latitudes of the moon, June 16, 1806, at 2h. 49' 30.1 and 5h. 34' 6".6 app. time, astronomical account at Greenwich, which correspond nearly to the beginning and end of the total eclipse of the sun as observed at Salem.

1806. June.	D long. N. A.	1st. diff.	2d. diff.	D lat. N. A.	1st. diff.	2d. diff.
	s ° ' "	° ' "	' "	° ' "	' "	' "
15d. midn.	2 14 48 58	7 17 21		— 1 14 6	+ 38 53	
16 noon.	2 22 6 19	A 7 20 53	+ 3 32	— 0 34 18	A — 40 48	+ 36
16 midn.	2 29 27 12	7 23 35	+ 2 42	+ 0 6 33	+ 40 55	+ 9
17 noon.	3 6 50 47		B = + 3 7	+ 0 47 28		B = + 31

* This may be found to minutes by Table XXX. by entering it at the top with half the arch A (because the table extends only to 3° 45') and at the side with the time T; the result doubled will be nearly the sought proportional part; but the table not being calculated to seconds, it is hardly accurate enough to be used in calculating eclipses. This correction may also be found by proportion; by saying as 12 hours to the time T, so is the arch A to the sought proportional part, and this method is the shortest when T is an aliquot part of 12 hours. Thus if T be 3, 6 or 9 hours, the proportional part will be $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{3}{4}$ of the arch A respectively. This method is made use of in Problem XVII. in interpolating the distances of the moon and sun.

† If the arch B consists of minutes and seconds, the correction for minutes, tens of seconds and single seconds, must be found separately, the sum of these three parts will be the sought correction. Proportional parts for the minutes of the time T may be taken in finding the correction of this table when necessary. In this rule, part of the correction of third difference is neglected. This part never exceeds $\frac{1}{10}$ of the third differences, and rarely amounts to a small fraction of a second.

TO FIND THE LONGITUDE, &c. OF THE SUN, MOON, AND PLANETS. 873

BEGINNING AT 2h 49' 50" T.							
Good longitude	24	22° 6' 19"		Second latitude N		- 0° 54' 17"	
30 58' Prop. part	+	1 41 53.8		A 40 46 Prop. part		+	9 37.0
3 7 Tab. XLV.	-		16.2	B 50 Tab. XLV		-	2.9
B's longitude	2	23 50 20		D's latitude N.		- 0 34 34.1	
END AT 5h 34 6" T.							
Good longitude	24	22° 6' 19"		Second latitude N.		- 0° 54' 15"	
30 58' Prop. part	+	3 24 35.3		A 40 46 Prop. part		+	18 55.0
3 7 Tab. XLV.	-		21.2	B 50 Tab. XLV.		-	3.2
D's longitude	2	25 30 51.1		D's latitude N		- 0 15 21.3	

The proportional parts of the arch A were calculated in this example by arithmetic without logarithms. By observations of the eclipse on that day, it was found that the moon's longitude was too great by 58".5 and her latitude too great by 11".4. These corrections are applied to the above longitudes and latitudes, in calculating the eclipse in Problem VI.

Remark 1 It will not be necessary to take notice of the second differences in calculating the parallax or semi-diameter of the moon, or any of the solar elements useful in calculating an eclipse or occultation. In this case the quantity immediately preceding and following the proposed time at Greenwich, must be taken from the Nautical Almanac, and their difference will be the arch A, also the difference between the proposed time and that taken first from the Nautical Almanac is to be called the time T. Then by proportion, as the interval between the times taken from the Nautical Almanac is to the time T, so is the arch A to the correction to be applied to the first quantity taken from the Nautical Almanac, additive if increasing, subtractive if decreasing. This correction may also be found by logarithms as above, using the constant logarithm 5.36152 if the interval of the times in the Nautical Almanac is 12 hours, and 0.6349 if the interval is 24 hours. The proportional part of the moon's parallax and semi-diameter may also be found by Table XI and that of the solar elements by Tables XXX. XXXI. as taught in the explanation of these tables. To exemplify this, the rest of the quantities requisite in calculating the eclipse and occultation (Prob. VI. VII.) are here found.

EXAMPLE I.

1801.	D. E.D.	D. H.P.	1801.	☉ long.	☉ R. A.
Dec. 12 midn.	16 17'	59 46'	Dec. 12 noon	24 20' 22" 4	17h 18' 4" 4
Dec. 12 noon	16 23	60 6	15 noon	1 21 23 10	17 22 23 5
Difference A.	6	20	Difference A.	1 1 6	4 25 1
Pro. T=2h 48' 29"		6.3	P + T=15h 48' 29"	40 13	2 34 6
Correspond. values	16 18.8	59 52.3	Correspond. val.	1 21 2 13	17 20 59 0
Pro. T=5h 1 29"		2.4	Pro. T=17h 4 29"	43 21	3 8 1
Correspond. values	16 12.5	59 54.4	Correspond. val.	1 21 3 23	17 21 12 3

EXAMPLE II.

1806.	D. E.D.	D. S.H.	1806.	☉ long.	☉ R. A.
June 16 noon.	16° 27'	60° 21'	June 16 noon.	24° 54' 18"	5h. 36' 20" 6
16 midn.	16 30	60 34	17 noon.	25 31 35	6 40 30 0
Differences A.	+ 3	+ 13	Differences A	57 17	4 9 4
Pr. part T 2h. 48' 59" 1	+ 0.7	+ 3.1	Pr. part T 2h. 48' 59" 1	+ 6 43.4	+ 23 4
Correspond. values	16 27.7	60 24.1	Correspond. val.	24 41 3.4	5 36 50 0
Pr. part T 5h. 34 6".8	+ 1.4	+ 8.6	Pr. part T 5h. 34' 6".8	+ 15 17.5	+ 57 9
Correspond. val.	16 22.4	60 27.0	Correspond. val.	14 47 35.5	5 27 18 5

The semi-diameters thus found must be decreased 2" for inflexion, and augmented by the correction Table XLIV in calculating an eclipse or occultation by Problem XIII. or in deducing the longitude from observations by Problems VI. VII. VIII. or IX.

The sun's semi-diameter by the Nautical Almanac, June 13, 1806, was 15' 46".3 and June 19, 1806, was 15' 45".9. Hence at the above time it was 15' 46".1. This in eclipses of the sun must be decreased 34" for irradiation.

Remark 2. The above rule for calculating the second differences of the lunar motions where the intervals in the Nautical Almanac are 12 hours, may be made use of when the intervals are three, six, &c. days, (as is the case with the elements of the motions of the planets) by taking two longitudes, latitudes, &c. before, and two after, the given time at Greenwich, and thence deducing the arches A, B, and the longitudes, latitudes, &c. and then making use instead of T, of the *quotient* of the difference between the given time and that marked in the Nautical Almanac against the second longitude, &c. divided by the number of half days in the given *interval*. Thus, if the interval is one day, the divisor is two; if the interval is 3 days, the divisor is 6, and if the interval is 6 days, the divisor is 12. Thus if it were required to find the geocentric longitude of Jupiter July 14d. 15h. 30, 1806, astron. acc. at Greenwich, the work would be as follows.

574 TO FIND THE HORARY MOTIONS OF THE SUN, MOON AND PLANETS.

July 7	2 $\frac{1}{2}$ long. 11 $\frac{1}{2}$ 18° 2'			Second longitude 11 $\frac{1}{2}$ 17° 59'
13	11 17 59	— 3'	— 8	A=—11' Prop. part — 2 52
19	11 17 48	A=—11	— 6	B=— 7' Tab. XLV. + 0
25	11 17 31	—17	B=— 7	2 $\frac{1}{2}$ longitude 11 17 56 4

In this example the time T, is 3h. 7' 30', found by dividing by 12, the interval between July 13 and July 14d. 13h. 30". In general the correction of Table XLV. may be neglected in calculating the places of the planets. In the above rule the intervals of time at which the longitudes, &c. are marked in the N. A. are supposed equal. If that should not be the case, the correction Table XLV. may be neglected, on account of the trouble of calculating it.

PROBLEM II.

To find the horary motion of the moon in long. lat. &c. at any given time at Greenwich.
RULE.

Take from the Nautical Almanac the four longitudes, latitudes, &c. two immediately preceding the given time at Greenwich, and two immediately following. Prefix the sign + to the southern latitudes or declinations, and the sign — to the northern. Then find the first and second differences, the Arch B, and the time T; as in Problem I. The mean of the two first differences, noticing the signs as in algebra, will be the approximate motion in 12 hours.

To the proportional logarithm of one fourth part of the time T add the proportional logarithm of the arch B, the sum will be the proportional logarithm of the correction of the approximate motion, to be applied to it with the same sign as the arch B, and the corrected motion of the moon in 12 hours will be obtained,* which divided by 12 will give the horary motion.

EXAMPLE I.

Required the horary motions of the moon in longitude Dec. 12, 1808, at 15h. 48' 29" and 17h. 1' 29" app. time at Greenwich.

This corresponds to Example I. preceding, in which T=3h. 48' 29" and 5h. 1' 29". The two first differences in longitude 7° 6' 16" and 7° 11' 18"; their mean 7° 8' 47" is the approximate motion in 12 hours, and the arch B is 4' 54".5. The rest of the calculation is as follows.

At 15h. 48' 29" T=3h. 48' 29"	
Arch B 4' 54" 5 P. L.	1.5644
$\frac{1}{4}$ T 57 7 P. L.	4925
Corr. + 1 33.....	2.0629
Approx. mot. 7 8 47	
Mot. 12 hours 7 10 20	
In 1 hour 35 51.7	

At 17h. 1' 29" T=5h. 1' 29"	
.....	1.5644
$\frac{1}{4}$ T 1h. 15' 22".....	P. L. 5781
Corr. + 2 3.....	P. L. 1.9425
Approx. mot. 7 8 47	
Mo. 12 hours 7 10 50	
In 1 hour 35 54.2	

In a similar manner, if the horary motion in latitude was required at 12d. 17h. 33', the two first differences in latitude are — 34' 21", and — 36' 45", their mean — 35' 33" is the approximate motion in 12 hours. The correction found by the above rule with the time T. 5h. 33' and the arch B=—2' 6".5 is — 59", whence the true motion in 12 hours is — 36' 32" which divided by 12 gives the horary motion — 3' 2".7. The negative sign — indicates that the north polar distance is decreasing, the positive sign + that it is increasing. In the present example the north polar distance was decreasing, and as the latitude was south, it was also decreasing, as is evident.

EXAMPLE II.

Required the horary motions of the moon in longitude June 16, 1806, at 2h. 49' 50".1 and 5h. 34' 6".6 app. time by astronomical computation at Greenwich.

This corresponds to Example II. preceding, in which T=2h. 49' 50".1 and 5h. 34' 6".6; the two first differences, are 7° 17' 21" and 7° 20' 53", the mean of which 7° 19' 7" is the approximate motion in 12 hours, the arch B is + 3' 7".

* The motion in 12 hours thus obtained, which for distinction will be called the arch M, is not perfectly accurate, since the third and higher orders of differences are neglected; but the horary motion deduced therefrom, is abundantly sufficient for the purpose of projecting an eclipse or occultation. When greater accuracy is required, the third differences may be taken into account in the following manner. Having found the second differences as above directed, subtract the first of them from the second, noting the sign as in Algebra, and call the remainder the arch b. Enter Table XLV. with this arch at the top, and the time T at the side, and take out the corresponding correction which is to be increased by one sixth part of the arch b, without noting the signs. To the quantity thus found is to be prefixed a sign different from that of the arch b, and then it is to be applied to the arch M with its sign to obtain the true motion in 12 hours. Thus in the above example the second differences of longitude are + 5' 2" + 4' 47". Subtracting the former from the latter, leaves the third difference or arch b = — 15". Corresponding to this and the time T 3h. 48' 29" in Table XLV. is 1".6 which increased by one sixth of b = 2".5 gives the sought correction 4".1 or 4". to which must be prefixed the sign + (because the sign of b is negative) making it + 4". This connected with the arch M = + 7° 10' 20" gives the true motion in 12 hours 7° 10' 24" whence the horary motion is 35' 52". In a similar manner, if the third differences were noticed in the above example for finding the horary motion in latitude, the two second differences are — 2' 34" and — 1' 48" the arch b = + 35" the correction of the motion in 12 hours — 56' 62" is — 10" making it — 56' 42" or 5' 5".5 per hour.

TO FIND THE ECLIPTIC CONJUNCTION OF THE SUN AND MOON. 575

At 2h. 49' 50" 1=T.		At 5h. 34' 6" 8=T	
Arch B= + 3' 7" P. L.	1.7610	Arch B= + 3' 7" P. L.	1.7616
Time T= 42 27 P. L.	6274	Time T= 1h. 23' 32" P. L.	3334
Correction + 0 44 P. L.	2.3890	Correction + 1 27 P. L.	2.0850
Approx. mot. 7 19 7		Approx. mot. 7 19 7	
Mot. in 12 hours 7 19 51		Mot. in 12 hours 7 20 34	
Mot. in 1 hour 36 39.2		Mot. in 1 hour 36 42.8	

EXAMPLE III.

Required the motion of the moon in right ascension in 12 hours, supposing it to increase uniformly with the velocity it had July 4th, 1808, at 9h. 26' app. time at Greenwich, by astronomical computation.

July 3, mid.	D R. A	226°. 57'	7° 29'	B= 4' 30"	P. L.	1.6021
4, noon	233 26	A 7 35	+6'	Time T=2h. 21 30	P. L.	1015
4, mid.	241 01	7 38	+3'	Correction + 3 32	P. L.	1.7084
5, noon	248 39	B=+4'	+4'	Approx. mot. 7 32 0		

True mot. in 12h. 7 35 32 or 30'.22'.1 in time.

In this example T=9h. 26' and the approx. motion is the half sum of 7° 29' and 7° 35'.

REMARKS.

1. When it is required to find the motion of the moon in any given interval of time, the motion in 12 hours must be found for the middle of that interval.

2. In calculating an occultation of a star by the moon, the relative horary motion in longitude is the same as the horary motion of the moon, because the star is at rest; but in calculating a solar eclipse, the sun's horary motion must be found in page III. of the Nautical Almanac, and subtracted from the moon's horary motion in longitude, the remainder will be the horary motion of the moon from the sun in longitude. Thus on the 16th of June, 1806, the sun's horary motion was 2' 23".1, which subtracted from the horary motions found in Example II. 36'. 39".2 and 36'. 42".8 leaves the corresponding horary motions of the moon from the sun in longitude 34' 16".1 and 34' 19".7.

As the sun has no sensible motion in latitude, the relative horary motion of the moon from the sun in latitude, is the same as the true horary motion of the moon in latitude.

3. The horary motion of a planet may be found in a similar manner, making use of the arches A. B. T. found as in Remark 2, Problem I. Thus if the horary motion of Jupiter was required July 14, 1808, at 13h. 30', the arch B= -7' T=3h. 7' 30", and the approximate motion in the interval 6 days is the half sum of the two first differences—3' and—11', namely—7' 0". The cor-

rection found as in the adjoining calculation is—1' 49", hence the motion in 6 days is—8' 49", whence

the horary motion is—3".67. The negative sign indicates that the motion is retrograde, or contrary to

the order of the signs: in this case the relative motion of the moon from the planet in longitude would

be found by adding their horary motions, because the motion of the moon is always direct. Similar remarks may be made in finding the horary motion of the moon from the planet in latitude.

PROBLEM III.

To find the time of the ecliptic conjunction or opposition of the moon with the sun, a planet, or a fixed star.

The time of the ecliptic conjunction of the sun and moon is the same as the time of new moon given for the meridian of Greenwich in the first page of the month of the Nautical Almanac. Thus in January 1808, the ecliptic conjunction is on the 27th day at 4h. 9' apparent time at Greenwich. The times of the ecliptic conjunction of the moon and those fixed stars with which there may be an occultation, are also given in the same page, being marked with Bayer's characters of reference. The time of conjunction is placed first, then the characters of the moon and star, or moon and planet. Thus in 1808, December 12d. 17h. 33' D a M, signifies that on the 12th day of December at 17h. 33' apparent time at Greenwich, the moon was in ecliptic conjunction with the star Spica, whose character is a M, and that there might be an occultation of that star. Also, December 15, 1808, 5h. 53' D h signifies that at that moment apparent time at Greenwich, the moon and Saturn were in ecliptic conjunction, and there might be an occultation of that planet. These times being reckoned according to astronomical computation, and in calculating them, no attention is paid to the parallaxes. The time of the ecliptic opposition of the sun and moon is the same as at the time of full moon given in the same page of the Nautical Almanac. Thus the full moon or ecliptic opposition in May, 1808, was 9d. 19h. 39' at Greenwich.

The time of the ecliptic conjunction, as given in the Nautical Almanac, is easily computed from the geocentric longitudes of the objects; and as it may sometimes be required to seconds, the rule is here inserted, adapted to the calculation of the conjunction of the sun and moon, which, with a slight modification, will answer for any of the planets.

RULE.

Take from the Nautical Almanac the two longitudes of the sun and moon at the noon and midnight preceding the time of the conjunction, and the two immediately following. Subtract the longitudes of the sun from those of the moon, noting the signs as in algebra, the remainders will represent the distances of the sun from the moon on the ecliptic. Subtract each of these from the following to obtain the first differences, and call the middle term the arch A, subtract each of these differences from the following for the second differences, and take their half sum or mean for the arch B, noting the signs as in algebra.

To the constant logarithm 4.63548 add the arithmetical complement of the log. of the arch A in seconds, and the log. of the second of the above found distances in seconds, the sum, rejecting 10 in the index, will be the logarithm of the approximate value of T in seconds.

With this time T at the side of Table XLV. and the arch B at the top, find the equation of second differences, the logarithm of which added to the two first logarithms used in finding T, will, in rejecting 10 in the index, give the logarithm of the correction of the approximate time T in seconds, to be applied to it with the same sign as the arch B, and the apparent time of the conjunction at Greenwich, counted from the second noon or midnight, taken from the Nautical Almanac, will be obtained. From which the time of conjunction under any other meridian may be easily obtained, by adding to it the longitude in time when east, or subtracting when west.

REMARK I. When the time of the ecliptic conjunction of the moon and a planet is required, the longitudes of the planet must be found by Problem I. for the noon and midnight immediately preceding, and those immediately following the time of the conjunction, and these are to be used in the above note instead of the sun's longitudes. If the ecliptic conjunction of the moon with a fixed star is required, its longitude must be found in Table XXXVII. and corrected for the equation of the equinoxes and aberration by Tables XL. XLI. as shown in the explanation of those Tables. This longitude is to be used instead of the sun's, in the above rule.

REMARK II. By the same rule, the time, when the moon is at any distance from the sun, may be found, by increasing the sun's longitudes given in the N. A. by the quantity the moon is supposed to be distant from the sun, counted according to the order of the signs. Then supposing a fictitious sun to move so as to have these increased longitudes at the corresponding times, and finding by the above rule the time of conjunction of the moon with this fictitious sun, which will be the sought time when the moon is at the proposed distance from the sun. Thus, to find the time of the first, second, or third quarter of the moon, the sun's longitudes must be increased 3, 6, or 9 signs respectively (rejecting as usual 12 signs when the sun exceeds that quantity.) Thus, if the first quarter of the moon which happened after midnight, July 29, 1808, was required. The sun's longitudes increased by 3 signs give the longitudes of the fictitious sun July 29d. 0h; 29d. 12h; 30d. 0h; and 30d. 12h. respectively, 7s. 6° 5' 44", 7s. 6° 34' 26", 7s. 7° 3' 9", and 7s. 7° 31' 51". The longitudes of the moon corresponding are 6s. 23° 49' 19", 7s. 0° 53' 34", 7s. 7° 57' 30", and 7s. 15° 0' 57". Hence the time of the conjunction of the moon with the fictitious sun found by the above rule, was July 29d. 22h. 21' at Greenwich, which is the time of the first quarter required. In a similar manner, by increasing the longitudes of a planet or a star, the time may be found when the moon is at any proposed distance from it.

EXAMPLE.

Required the time of the ecliptic conjunction of the sun and moon, in Jan. 1808?

1808, Jan.	☽ Long.	☉ Long.	Distances.	1st. diff.	2d. diff.
26d. 12h.	9 27 56 46	10 5 57 26	—8 0 40		
27 0	10 4 25 2	10 6 27 56	—2 2 54	+ 5 57 46	— 3 15
27 12	10 10 50 3	10 6 58 26	+ 3 51 37	A=+ 5 54 31	— 3 22
28 0	10 17 11 41	10 7 28 55	+ 9 42 46	+ 5 51 09	B=— 3 18
Constant 4.63548					
A	5° 54' 31" = 21271	log. co ar.	5.67221		5.67221
2 dis.	2 2 54 = 7374	log.	3.86770	Tab XLV. Cor. 22'.4	log. 1.38035
T	14976" = 4h. 9' 36"		4.17539	Correction 45"	log. 1.63794
Correction	—45				

Conjunction 4 8 51 past noon Jan. 27, at Greenwich, apparent time, which agrees nearly with 4h. 9' marked in the Nautical Almanac. The time of conjunc-

* The sun's longitude at midnight is the mean of the longitudes on the preceding and following noon.

578 TO FIND THE ALTITUDE AND LONGITUDE OF THE NONAGESIMAL.

twice in calculating a partial eclipse or occultation, and four times in a total, or annular eclipse or transit, it will tend considerably to abridge the calculations, to have a table like the following, containing their values for various places, for the obliquity $23^{\circ} 27' 40''$, with the variations for an increase of $100''$ in the latitude or obliquity. The logarithms A, B, C, of the table, were calculated in the following manner.

In north latitudes subtract the reduced latitude from 90° , in south latitudes add the reduced latitude to 90° , the sum or difference will be the polar distance; take half of this and half of the obliquity of the ecliptic $11^{\circ} 43' 50''$, and find the sum and difference. Then

Log. A is equal to the log. co-sine of the difference added to the log. secant of the sum, rejecting 20 in the index.

Log. C is equal to the log. tangent of the sum.

Log. B is equal to the log. tangent of the difference, increasing the index by 10, less the log. C.

Thus for Salem in the reduced latitude $42^{\circ} 22' 4''$, the half polar distance is $23^{\circ} 45' 55''$, the half obliquity $11^{\circ} 43' 50''$, the difference $12^{\circ} 5' 8''$, the sum $35^{\circ} 32' 48''$.

Difference.....	12° 5' 8"	Co-sine	9.99027	Tang. +10=	19.33065
Sum	35 32 48	Secant	10.08956	Tang.=C=	9.85408
Sum A.....				Diff.	B 9.47663

In this way the logarithms may be found for places not included in the table. The changes for an increase of $100''$ in the latitude or obliquity, are found by repeating the operation with these increased values, and ascertaining the corresponding changes in the values of A, B, C. These logarithms are given to six places of figures, though in general five will be quite sufficient, since the latitude and longitude of the nonagesimal are rarely required to a greater degree of accuracy than $10''$.

Places.	Reduced Latitude North.			A.	Var. A.		B	Var. B.		C.	Var. C.	
					+100".			+100".			+100".	
					Lat.	Obl.		Lat.	Obl.		Lat.	Obl.
	°	'	"		—	+		—	+		—	+
Albany	42	27	13	0.079670	53	97	9.475733	293	739	9.853328	223	223
Berlin	52	20	24	0.061608	49	75	9.524135	618	1099	9.771197	240	240
Cambridge, E.	52	1	28	0.062166	49	76	9.531054	600	1080	9.773925	240	240
Cambridge, A.	42	12	2	0.080150	52	97	9.478383	288	733	9.855355	222	222
Dublin obs.	53	12	7	0.060090	48	73	9.504166	670	1155	9.763705	242	242
Edinburgh	55	46	2	0.055618	47	67	9.233401	872	1376	9.741011	246	246
Greenwich obs.	51	17	28	0.063466	49	77	9.346396	562	1038	9.780232	238	238
Havana	23	3	34	0.120000	64	148	9.697658	85	516	10.009045	210	210
Kinderhook	42	11	37	0.080163	52	98	9.478455	289	733	9.855411	222	222
Lancaster	39	51	18	0.084648	54	104	9.501042	249	688	9.874005	219	219
Leon I. obs.	36	16	52	0.091680	55	112	9.529940	202	634	9.902005	216	216
London	51	19	29	0.063406	49	77	9.345714	564	1040	9.779044	238	238
Natchez	31	17	36	0.101899	58	125	9.561510	152	577	9.940447	212	212
Oxford obs.	51	34	26	0.062963	50	77	9.340586	576	1054	9.777800	239	239
Paris	48	38	51	0.068207	50	83	9.394413	452	918	9.802627	233	233
Philadelphia	39	45	44	0.084828	53	104	9.501872	248	687	9.874738	219	219
Richmond obs.	51	16	56	0.063482	49	78	9.346576	562	1038	9.780308	238	238
Rutland	43	24	32	0.077866	52	95	9.465330	312	780	9.845648	224	224
Salem	42	22	4	0.079832	52	98	9.476637	291	731	9.854016	222	222
Place Prob. VII.	19	52	38	0.127485	66	157	9.607602	78	500	10.027183	211	211

These logarithms are calculated for the obliquity $23^{\circ} 27' 40''$. The columns marked Lat. represent the variations of A, B, C, for an increase of $100''$ in the reduced lat. The column Obl. represents the variations of A, B, C, for an increase of $100''$ in the obliquity of the ecliptic. The signs must be changed if the latitude or obliquity is less than that used in calculating the table.

EXAMPLE.

Required the values of A, B, C, for Salem, when the obliquity is $23^{\circ} 27' 45''$?

Tabular numbers	0.079832	9.476637	9.854016
Var. for + 8'' Obl.	+ 8	— 58	+ 15
Sought values	A=0.079840	B=9.476579	C=9.854031

FIND THE ALTITUDE AND LONGITUDE OF THE NONAGESIMAL. 579

Abridged method of calculating the altitude and longitude of the Nonagesimal, by the preceding Table.

Add together the sun's right ascension, the apparent time at the place of observation, (counted from noon to noon) and 6 hours, the sum, rejecting 24 or 48 hours if greater than those quantities, is to be called the time T; this is to be sought for in the column of hours of Table XXVII. supposing the column marked A. M. to be increased 12 hours, as in the astronomical computation.* The corresponding log. co-tangent, added to the log. A of the Table, gives the log. tangent of the arch G; this added to the log. B of the Table, rejecting 10 in the index, will be the log-tangent of the arch F; these arches being less than 90° when T is found in the column A. M. otherwise greater.† [This rule is general, except in places situated within the polar circles, which is a case that very rarely occurs. Within the north polar circle, the supplement of F to 360°, is to be used instead of F; within the south polar circle, the supplement of G to 180°, is to be taken instead of G, the other terms remaining unaltered.] Then the longitude of the Nonagesimal is equal to the sum of the arches F, G, and 90°, neglecting as usual 360° when the sum exceeds that quantity.

To the tabular log. C, add the log. co-sine of the arch G, and the log. secant of the arch F, the sum, rejecting 20 in the index, will be the log-tangent of half the altitude of the Nonagesimal.‡

EXAMPLE I.

Required the altitudes and longitudes of the Nonagesimal at Salem, June 16, 1806, at the times of the beginning and end of the eclipse, calculated in Problem VI.?

Beginning of the Eclipse.

h.	5	38	50.0	☉ R. Ascension			
	22	6	18.1	Apparent time			
	0			A		0.07934	
T	9	43	8.1	Co-tan.		9.48826	
G	159°	42'	0"	Tan.	9.56810	Co-s.	9.97215
	90			B	9.47658	C	9.85403
F	173	40	31	Tan.	9.04468	Sec.	10.00265
	63	22	51	=lon. N.	33	59	25
				Tan.	9.82883		
Altitude Nonages							67 58 50

End of the Eclipse.

h.	5	37	18.5	☉ R. Ascension			
	0	50	34.6	Apparent time			
	6			A		0.07984	
T	12	27	58.1	Co-tan.		8.78470	
G	4°	11'	13"	Tan.	8.86454	Co-s.	9.99884
	90			B	9.47658	C	9.85403
F	1	15	23	Tan.	8.34112	Sec.	10.00010
	95	28	36	=lon. N.	35	28	53
				Tan.	9.85297		
Altitude Nonages							70 57 46

EXAMPLE II.

Required the altitudes and longitudes of the Nonagesimal at the times and places mentioned in the Example of Problem VII.?

Immersion.

h.	17	20	59	☉ R. Ascension			
	18	57	29	Apparent time			
	6			A		0.12748	
T	16	18	28	Co-tan.		9.80098	
G	40°	18'	7"	Tan.	9.92846	Co-s.	9.88233
	90			B	9.60761	C	10.02718
F	18	57	48	Tan.	9.53607	Sec.	10.02423
	149	15	53	=lon. N.	40	38	46
				Tan.	9.93374		
Altitude Nonages							81 17 32

Emergence.

h.	17	21	12.5	☉ R. Ascension			
	18	10	29	Apparent time			
	6			A		0.12748	
T	17	31	41.5	Co-tan.		9.94622	
G	49°	50'	18"	Tan.	10.07370	Co-s.	9.80552
	90			B	9.60761	C	10.02718
F	25	38	40	Tan.	9.68131	Sec.	10.04604
	165	28	58	=lon. N.	37	17	39
				Tan.	9.88175		
Altitude Nonages							74 53 18

In these calculations it is usual to take the sun's right ascension, and the apparent times, to tenths of a second, and to take proportional parts for the seconds and tenths in finding the logarithms. Thus in Example I. in finding the log. co. tang. of 9h. 43' 8".1; the nearest logarithms are 9.48849, 9.48904, corresponding to the 9h. 43' 4", and 9h. 43' 12". These logarithms differ 45, the times 8", and the difference between 9h. 43' 4", and 9h. 43' 8".1, is 4".1. Hence 8" : 45 :: 4".1 : 23 the correction to be subtracted from the first log. 9.48849, (because it is decreasing) to obtain the sought log. co-tang. 9.48826.

* Thus if the time T is 5 hours, it must be called 5h. P. M. If T is 14 hours, it must be called 2h. A. M. In making use of a common table of logarithms, you must turn the time T into degrees, and make use of the log. co-tangent of its half.

† The arches F, G, are acute when the time T is found in the column A. M. otherwise obtuse. This is easily remembered from the circumstance that a is the first letter of acute and A. M. Some writers have not taken notice of the cases of the values of F, G, within the polar circles.

‡ Strictly speaking, the quantity thus obtained is the distance between the north pole of the ecliptic and the zenith of the place, which, in southern latitudes, and between the tropics, is frequently the supplement of the altitude of the Nonagesimal. The above form is made use of to simplify the rules for applying the parallaxes. It is immaterial whether the altitude of the Nonagesimal, or its supplement, is made use of in Table XLIV.

PROBLEM V.

Given the altitude and longitude of the Nonagesimal; the longitude, latitude and horizontal parallax of the moon, and the latitude of the place of observation, to find the moon's parallax in latitude and longitude.

RULE BY COMMON LOGARITHMS.

From the horizontal parallax of the moon, subtract its correction from Table XXXVIII. corresponding to the latitude of the place, the remainder, in occultations of a fixed star, will be the *reduced* parallax; but in solar eclipses this quantity is to be diminished by the sun's horizontal parallax, $8''.8^*$ to obtain the *reduced* parallax.

To the logarithm of the reduced parallax in seconds, add the log. sine of the altitude of the Nonagesimal, and the log. secant of the moon's *true* latitude†, the sum, rejecting 20 in the index, will be a constant log. From the moon's true longitude, increased by 360° if necessary, subtract the longitude of the Nonagesimal, the remainder will be the *moon's distance from the Nonagesimal*, which if less than 180° is to be called the arch D, otherwise its supplement to 360° is to be called the arch D. To the constant logarithm, add the log. sine of D, the sum, rejecting 10 in the index, will be the logarithm of the *approximate* parallax in longitude in seconds, which add to the arch D, then take the log-sine of the sum, and add it to the constant logarithm, rejecting 10 in the index, and the logarithm of the *corrected* parallax will be obtained. This will in general be sufficiently exact, but when great accuracy is required, the operation may be again repeated, by adding the arch D to the *corrected* parallax;‡ then to the log. sine of the sum add the constant logarithm, rejecting 10 in the index, and the logarithm of the *parallax in longitude* P will be obtained. This is to be *added* to the *true* longitude of the moon when her distance from the Nonagesimal is *less* than 180° , otherwise *subtracted* to obtain her *apparent longitude*.

If the true latitude of the moon is *south*, prefix the sign + to it, if *north* the sign —. Then to the logarithm of the reduced parallax in seconds, add the log. co-sine of the altitude of the Nonagesimal, and the log. co-sine of the moon's apparent latitude,§ the sum, rejecting 20 in the index, will be the logarithm of the *first part* of the parallax in latitude in seconds, to which prefix the sign + when the altitude of the Nonagesimal is less than 90° , otherwise the sign —, this added to the true latitude of the moon, due regard being had to the signs, will give her *approximate* latitude.

To the logarithm of the reduced parallax in seconds add the log. sine of the altitude of the Nonagesimal, the log. sine of the moon's approximate latitude, and the log. co-sine of the sum of the arches D and $\frac{1}{2}$ P, the sum, rejecting 30 in the index, will be the logarithm of the *second part* of the parallax in latitude in seconds, to which prefix the sign — when the arches D + $\frac{1}{2}$ P, and the approximate polar distance¶ are both greater or both less than 90° , otherwise the sign +, this term connected with the approximate latitude will give the *apparent latitude* of the moon,** which will be south if + north if —. The moon's *true* latitude subtracted from her *apparent* latitude, noticing the signs, will give the *parallax in latitude*.

BY PROPORTIONAL LOGARITHMS.

The above rule will answer in calculating by proportional logarithms, with the following alterations. When the log. sine occurs, read log. co-secant; for log. co-sine read log. secant; for log. secant read log. co-sine; and for log. co-secant read

* This is the mean value of the sun's parallax, and may be used instead of the true parallax, which varies from $8''.7$ to $8''.9$. The true solar parallax at any time may be found by subtracting the logarithm of the sun's distance, given in the Nautical Almanac, from the log. of $8''.8$, increasing the index by 10 when necessary, the remainder will be the logarithm of the sought parallax in seconds.

† Corrected for the errors of the tables, when known.

§ This sum D + cor. par. is nearly equal to D + P the apparent distance of the moon from the Nonagesimal, to be made use of in Table XLIV. in finding the augmentation of the moon's S. D.

¶ In solar eclipses the apparent latitude is so small that its log. sine may be put equal to 10.00000. In occultations you must calculate the first part of the parallax in altitude by approximation, making use of the true latitude instead of the apparent in the above rule, and deducing the approximate value of the first part of the parallax: this applied to the true latitude will give the approximate apparent latitude, with which the operation is to be repeated, and the first part of the parallax will be obtained to a sufficient degree of exactness.

¶ The apparent polar distance is found by adding + 90° to the approximate latitude, due regard being had to the signs. To be perfectly accurate, the apparent instead of the approximate latitude ought to be made use of in this part of the calculation, and the logarithms of this term ought to be increased by the log. secant less radius of $\frac{1}{2}$ P; but these corrections are too small to affect the result. In calculating the second part of the parallax in latitude, it will be sufficient to take the logarithms to three or four places of the decimals.

** This rule gives the apparent latitude in all cases, but it may not be amiss to observe, that in several late publications the cases where the moon is between the zenith and the elevated pole are by mistake neglected.

log. sine. The parallaxes may be calculated to the nearest second by proportional logarithms. When greater accuracy is required, common logarithms must be made use of.

To illustrate this rule, the following examples, corresponding to the times of the beginning and end of the total eclipse of the sun, of June 16, 1806, as observed at Salem, are given. The elements necessary for this purpose have already been calculated in Problems I. and IV. For greater accuracy the longitudes and latitudes of the moon are corrected for the errors—58".5 in longitude, and — 11".4 in latitude, which were found by comparing several observations of the eclipse made at different places.

EXAMPLE I.

Given the altitude of the Nonagesimal $67^{\circ} 58' 50''$, its longitude $63^{\circ} 22' 31''$, the longitude of the moon $83^{\circ} 49' 3''.5$ her latitude $24' 27''.4$ N. her horizontal parallax $60' 24''.1$, the latitude of the place of observation $42^{\circ} 33' 30''$: required the parallaxes in longitude and latitude?

The correction in Table XXXVIII. corresponding to the latitude $42^{\circ} 33' 30''$, and parallax $60' 24''.1$ is $5''.6$, this and the sun's horizontal parallax $8''.8$ subtracted from the D's horizontal parallax $60' 24''.1$ leaves the *reduced* parallax $60' 9''.7=3609''.7$. The longitude of the Nonagesimal $63^{\circ} 22' 31''$ subtracted from the moon's longitude $83^{\circ} 49' 3''$, leaves the *moon's distance from the Nonagesimal*, $20^{\circ} 26' 32''$ equal to the arch D, because less than 180° .

Calculation by common Logarithms.

Reduced par.	3609' 7	Log.	3.55747	Reduced par.	3609' 7	Log.	3.55747
Alt. Nonag.	67 58 50	Sine	9.96710	Alt. Nonag.	67 58 50	Co-si.	9.57394
D's true lat.	24 27.4	Sec.	10.00001	D's app. lat.		Co-si.	10.00000
Constant log.			3.52458	1 part p. 1353'.3 = + 22' 33''.3		Log.	3.13141
D	20 26 32	Sine	9.54315	D's true latitude	— 24 27.4		
Appr. par.	1169'=19 29	Log.	3.06773	D's approx. lat.	— 1 54.1	Sine	6.743
D + Appr. par.	20 46 1	Sine	9.54970	Reduced parallax		Log.	3.557
Constant log.			3.52458	Alt. Nonag.		Sine	9.967
Cor. par.	=1187'=19 47	Log.	3.07428	D + $\frac{1}{2}$ P.	20 36 25	Co-si.	9.971
D + cor. par.	20 46 19	Sine	9.54980	2 part par.	— 1'.7	Log.	0.238
Constant log.			3.52458	Approx. lat.	— 1 54 1		
Par. long. P 1186''.8=19' 46.8		Log.	3.07438	D's app. lat.	— 1 55 8 or 1' 55''.8 N.		
D's true longitude	83 49 3.5						
D's app. long.	84 8 50.3						

EXAMPLE II.

Given the altitude of the Nonagesimal $70^{\circ} 57' 46''$, its longitude $95^{\circ} 26' 36''$, the longitude of the moon $85^{\circ} 29' 32''.6$, her latitude $15' 10''.4$ N. her horizontal parallax $60' 27''.0$, the latitude of the place of observation $42^{\circ} 33' 30''$. Required the parallaxes in longitude and latitude?

The correction in Table XXXVIII. corresponding to the latitude $42^{\circ} 33' 30''$ and parallax $60' 27''$, is $5''.6$, this and the sun's horizontal parallax $8''.8$, subtracted from the moon's horizontal parallax $60' 27''.0$ leaves the *reduced* parallax $60' 12''.6$. The longitude of the Nonagesimal $95^{\circ} 26' 36''$, subtracted from the moon's longitude increased by 360° , viz. $445^{\circ} 29' 33''$, leaves the *moon's distance from the Nonagesimal* $350^{\circ} 2' 57''$, the supplement of which to 360° is $9^{\circ} 57' 3''$, equal the arch D.

By proportional Logarithms.

Reduced par.	60' 12''.6	P. L.	0.4758	Reduced par.	60' 12''.6	P. L.	0.4758
Alt. Nonag.	70 57 46	Co-se.	10.0244	Alt. Nonag.	70 57 46	Sec.	10.4865
D's true lat.	15 10.4	Co-si.	10.0000	D's app. lat.		Sec.	10.0000
Constant log.			0.5000	1 part par. lat. + 19 38 5		P. L.	0.9621
D	9 57 3	Co-se.	10.7624	D's true lat.	— 15 10 4		
Approx. par.	9 50	P. L.	1.2624	D's appr. lat.	+ 4 28 1	Co-se.	12.886
D + appr. par.	10 6 53	Co-se.	10.7554	Reduced par.		P. L.	0.4758
Constant log.			0.5000	Alt. Nonag.		Co-se.	10.0244
Corrected par.	10 0	P. L.	1.2654	D + $\frac{1}{2}$ P.	10 2 3	Sec.	10.0067
D + cor. par.	10 7 3	Co-se.	10.7553	2 part par. lat. + 4.4		P. L.	3.3827
Constant log.			0.5000	Approx. lat.	+ 4 28.1		
Par. long. P.	10 0.0	P. L.	1.2653	Apparent lat.	+ 4 32.5 or 4' 32''.5 S.		
D's true long.	85 29 32.6						
D's app. long.	85 19 32.6						

EXAMPLE III.

Required the parallaxes in longitude and latitude at the time of the occultation of Spica, Dec. 12, 1808, at the times and place mentioned in the Example of Problem VII.

Immersion.

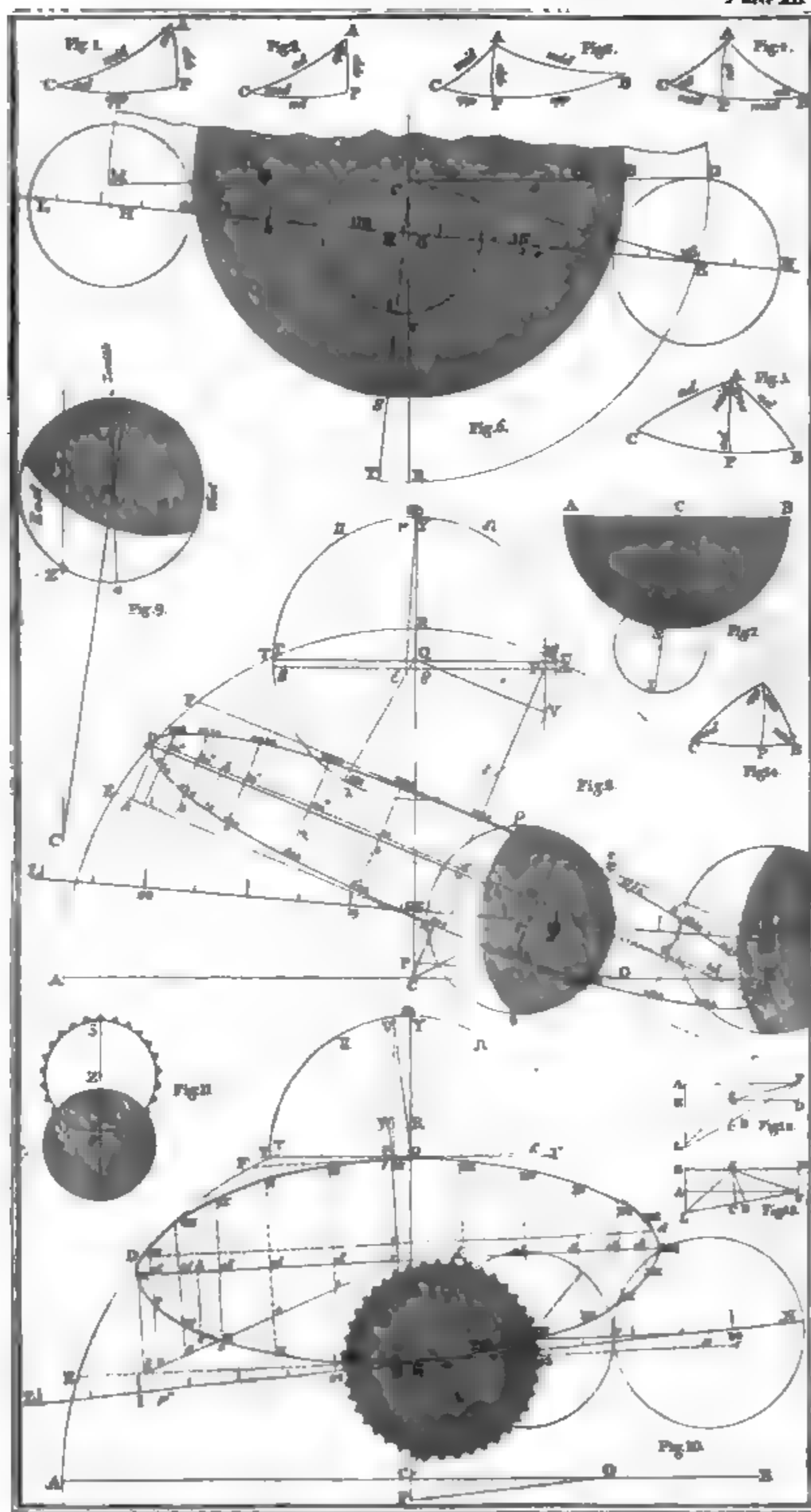
Reduced par.	59' 50" .9	P. L.	0.4782	.....	Sec.	0.472
Alt. Non.	81 17 32	Co-sec.	10.0050	.....	Sec.	0.479
D's true lat.	1 55 11	Co-si.	9.9998	D app. lat.*		Sec. 10.0008
Constant			4830	1 part par. lat. +	9' 8" .3	P. L. 1.294
D	50 52 1	Co-sec.	10.1103	D true lat. +	1 55 11.0	
Appr. par.	45 55	P. L.	5933	D approx. lat. +	2 4 14.3	Co-sec. 11.403
D + appr. par.	51 37 56	Co-sec.	10.1057	Reduced par.		P. L. 0.472
Constant			4830	Alt. Nonag.		Co-sec. 10.0050
Corrected par.	46 25	P. L.	5887	D + $\frac{1}{2}$ P	51 15 13	Sec. 10.0008
D + corr. par.	51 38 26	Co-sec.	10.1056	2 part par. lat. +	1 20.5	P. L. 2.008
Constant			4830	D approx lat. +	2 4 14.3	
Par. long. P.	+ 46 25	P. L.	5886	D app. lat. +	2 5 34.6 South.	
D true long.	200 7 56.3			D par. lat. +	10 23.8	
D app. long.	200 54 21.3					

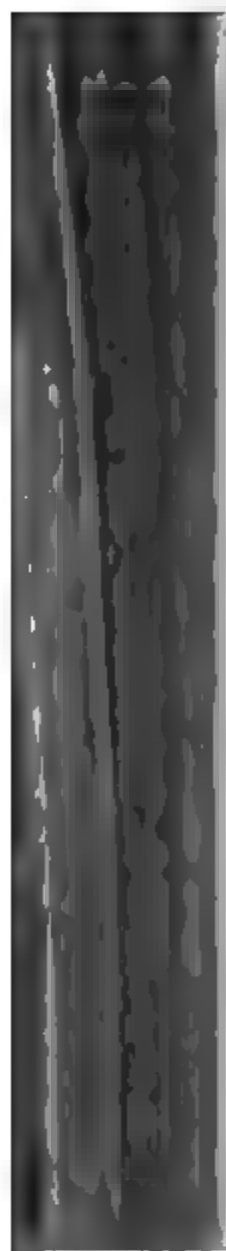
Emersion.

Reduced par.	59' 53" 0	P. L.	0.4780	.....	Sec.	0.479
Alt. Non.	74 35 18	Co-sec.	10.0159	.....	Sec.	10.373
D true lat.	1 51 29.1	Co-si.	9.9998	D app. lat.		Sec. 10.0008
Constant			0.4937	1 part par. lat. +	15' 54" .2	P. L. 1.008
D	35 22 38	Co-sec.	10.2374	D true lat. +	1 51 29.1	
Appr. par.	63 26	P. L.	7311	D approx. lat. +	2 7 23.3	Co-sec. 11.433
D + appr. par.	35 56 4	Co-sec.	10.2315	Reduced par.		P. L. 0.4780
Constant			4937	Alt. Nonag.		Co-sec. 10.0159
Corrected par.	33 54	P. L.	7252	D + $\frac{1}{2}$ P	35 39 35	Sec. 10.0002
D + corr. par.	35 56 32	Co-sec.	10.2314	2 part par lat. +	1 44.2	P. L. 2.014
Constant			4937	D approx. lat. +	2 7 23.3	
Par. long. P.	+ 33 54	P. L.	7251	D appar. lat. +	2 9 7.5 South	
D true long.	200 51 36.1			D par. lat. +	17 32.4	
D app. long.	201 25 30.1					

Having thus explained the method of calculating the parallaxes of the moon, it now remains to give the rules for finding the longitude by eclipses and occultations. The main object in these calculations is to determine from the observed beginning or end of the eclipse or occultation, the precise time of the ecliptic conjunction of the sun, or star and moon, free from the effects of parallax, counted on the meridian of the place of observation, since the difference of the times of conjunction, obtained in this manner at two places, will be their difference of longitude. If the lunar and solar tables were perfectly correct, the longitude might be determined by taking the difference between the time of conjunction, given in the Nautical Almanac, and that deduced from the observations of the eclipse or occultation; but it is much more accurate to compare the times deduced from observations actually made at the places for which the difference of longitude is sought. There are two different methods of finding the ecliptic conjunction, according as the latitude of the moon is supposed to be accurately known or not. If the latitude was given correctly by the lunar tables, or was accurately known by other observations, the ecliptic conjunction, and the longitude of the place, might be determined by each of the phases of the eclipse or occultation, by the method given in Problems VIII. and IX. But the moon's latitude not being generally given to a sufficient degree of accuracy, it is usual to combine together the observations of the beginning and end of the eclipse or occultation, or the beginning and end of total darkness in a total eclipse, or the two internal contacts of an annular eclipse, to ascertain the error of the moon's latitude, by the method given in Problems VI. and VII. In making the calculations in these Problems, it will be necessary to know nearly the longitude of the place, in order to find the supposed time at Greenwich, so as to take out the elements from the Nautical Almanac: and if the longitude, deduced from the observation, should differ considerably, the operation must be repeated with the longitude obtained by this operation.

* The moon's true latitude $1^{\circ} 55' 11''$ must first be used, its log. secant being 10.0002, which give the 1st part par. $9' 8''$, which, added to the true latitude of the moon, gives the app. lat. nearly $2^{\circ} 4' 14''$ the log. secant of which is 10.0003, as above. The calculation for the emersion is made in a similar manner.





PROBLEM VI.

Given the latitude of the place, and the apparent times of the beginning and end of a solar eclipse, counted from noon to noon, according to the method of Astronomers, to find the longitude of the place of observation.

In the rule for solving this Problem, references will be made to fig. 12, Plate XII. in which DSE represents a small arch of the ecliptic, S, the place of the centre of the sun, supposed at rest, F, L, the apparent places of the centre of the moon at the beginning and end of the eclipse respectively, FD, SC, and ALL, are perpendicular to DE, FA parallel to DE, and SB perpendicular to FL. Then it is evident that FD, LE represent the apparent latitudes of the moon, which fall below DE if south, above if north; and SF, SL represent the sums of the corrected semi-diameters of the sun and moon, at the beginning and end of the eclipse respectively.

RULE.

To the apparent times of the beginning and end of the eclipse add the estimated longitude of the place in time if it is west, but subtract if east, the sum or difference will be the supposed time at Greenwich, corresponding to which, in the Nautical Almanac, find, by Problem I. the moon's semi-diameter, horizontal parallax, longitude and latitude,* and the sun's semi-diameter, longitude and right ascension, also the moon's horary motion from the sun, by Problem II. Decrease the sun's semi-diameter $3\frac{1}{4}'$ for irradiation, and the remainder will be his corrected semi-diameter. Decrease the moon's semi-diameter 2' for inflexion, and to the remainder add the correction in Table XLIV.† the sum will be the moon's corrected semi-diameter. Find also, in the Nautical Almanac, the obliquity of the ecliptic.

With these elements and the apparent time at the place of observation, calculate the altitudes and longitudes of the Nonagesimal, by Problem IV. the parallaxes in longitude and latitude, and the moon's apparent longitudes and latitudes, by Problem V.

Take the difference between the apparent longitudes of the moon at the beginning and end of the eclipse, and subtract therefrom the difference of the sun's longitudes at the same times, the remainder will be the relative motion in longitude DL or FA. The relative motion in latitude AL, is found by taking the difference of the moon's apparent latitudes at the beginning and end of the eclipse, if they are both north, or both south, but their sum, if one be north, the other south. From the logarithm of FA, increasing the index by 10, subtract the logarithm of AL, the remainder will be the log-tangent of the angle of inclination DSB, this angle is to be taken greater than 90° when the moon's apparent latitude FD, at the beginning of the eclipse, is greater than at the end FL, otherwise less.‡ Then to the log co-secant of the angle of inclination, add the logarithm of the relative motion in longitude FA, the sum, rejecting 10 in the index, will be the logarithm of the apparent motion of the moon FL on her relative orbit. Then in the triangle SFL, the sides SF, SL, represent the sums of the corrected semi-diameters of the sun and moon at the beginning and end of the eclipse, and these with the relative motion FL, are given to find the angle FSB, (by Case VI Obl. Trig.) Thus to the log ar co. of FL, add the log of the sum of SF and SL, and the log of their difference the sum, rejecting 10 in the index, will be the logarithm of the difference of the segments FB, BL, half of which, added to, and subtracted from half of FL, will give the two segments FB, BL, the greater segment being contiguous to the greater side, whether SF or SL. Then from the logarithm of the segment FB, increasing the index by 10, subtract the log. of SF, the remainder will be the log. sine of the angle FSB,|| which is always less than 90°.

* Corrected for the errors of the tables in longitude and latitude when known.

† This correction must be found after the altitude and longitude of the Nonagesimal are calculated.

‡ This rule is equally true whether the latitude ω of the same or different names. If the latitudes are equal, and of the same name the angle DSB will be 90°. If they are equal, but of different names, the angle DSB may be taken acute or obtuse, since in this case the angle FSB is 90°. Strictly speaking, when the points F, L, fall on different sides of the line DE, the angle DSB is greater or less than

90° according as the expression $\frac{FD}{SF}$ is greater or less than $\frac{FL}{SL}$ but as the divisors SL and SF are nearly equal, they may be neglected, as in the above rule) except in a case which very rarely occurs namely when the difference of SL, SF is greater than the difference of the two app. latitudes EL, FD, in which case the rule in this note must be made use of. Observing that the fractions

$\frac{EL}{FD}$ — represent the quotients of the moon's apparent latitudes divided by the sum of the semi-diameters of the sun and moon

|| When SF, SL are equal, or their difference is so small that it may be neglected, the log. sine of the angle FSB may be obtained much more expeditiously by subtracting the log of the sum of SF and SL, from the log of FL increasing the index by 10. This method may almost always be made use of without much error. It is the rule adopted by Doctor Mackay in his treatise on longitude.

the difference between this and the angle of inclination DSB, will be the *central angle* DSF.

To the log. co-sine of the *central angle*, add the log. of the sum of the corrected semi-diameters at the beginning of the eclipse SF, rejecting 10 in the index, the sum will be the logarithm of SD, the apparent difference of longitude of the sun and moon at that time. This is to be subtracted from the longitude of the sun at the beginning of the eclipse, if the central angle is less than 90° , but added if greater than 90° , the sum or difference will be the moon's apparent longitude: to this must be *added* the moon's parallax in longitude, when her distance from the Nonagesimal (found as in Problem V. by subtracting the longitude of the Nonagesimal from the moon's longitude, borrowing 360° when necessary,) is greater than 180° , otherwise the parallax must be *subtracted*; the sum or difference will be the moon's *true longitude* at the beginning of the eclipse.

Take the difference in seconds, between the sun's and moon's *true longitudes* at the beginning of the eclipse, to the logarithm of which add the arith. comp. log. of the moon's horary motion from the sun* in seconds, and the constant logarithm 3.55630: the sum, rejecting 10 in the index, will be the logarithm of the time from the conjunction in seconds, which is to be added to the observed apparent time of the beginning of the eclipse, when the sun's longitude at that time is greater than the moon's *true longitude*, otherwise subtracted; the sum or difference will be the apparent time of the true ecliptic conjunction of the sun and moon at the place of observation. The difference between this and the time of conjunction at Greenwich, inferred from the Nautical Almanac by Problem III. will be the longitude of the place of observation. But if corresponding observations have been made at different places it will be much more accurate to find the times of the conjunction at each place by the above rule, and the difference of these times will be the difference of meridians, if it does not differ much from the supposed difference of longitude. If there is considerable difference, the operation must be repeated, making use of the longitude found by this operation; and thus by successive operations, the true longitude may be obtained.

The long. of the place of observation being accurately known, the errors of the lunar tables in long. and latitude may be easily found. For the difference between the moon's *true longitude* deduced by the above method from the observations, and the longitude found from the Nautical Almanac, will be the error of the tables in longitude. To find the error in latitude, add the log. sine of the central angle DSF to the log. of the sum of the corrected semi-diameters at the beginning of the eclipse SF, the sum, rejecting 10 in the index, will be the logarithm of the moon's apparent latitude FD at that time, which will be south, if the point F falls below D, otherwise north. Take the difference between this and the moon's apparent latitude found by Problem V. if they are both north, or both south; but their sum, if one be north and the other south, and the error of the tables in latitude will be obtained.†

REMARK.

The above rule will answer for deducing the longitude from the observed beginning and end of the internal contacts of a total or annular eclipse. The differences consist in reading the rule, beginning and end of the internal contacts, instead of beginning and end of the eclipse, and taking SF, SL equal to the differences of the corresponding semi-diameters, instead of their sums.

EXAMPLE.

At Salem, in the latitude of $42^\circ 33' 30''$ N. longitude by estimation 4h. 43' 33" W. from Greenwich, the beginning of the total eclipse of June, 1806, was observed at 15d. 22h 6' 18".1, and the end at the 16d. 0h. 50' 34".6, apparent time, by astronomical computation. Required the longitude of the place of observation?

Most of the following elements are calculated in Problems I. II. IV. V.

* When the horary motion varies, it must be taken to correspond to the middle time between the beginning of the eclipse, and the conjunction or new moon.

† When the eclipse or occultation is nearly central or (in other words) when FD, EL are very small in comparison of SF, the latitude thus found cannot be depended on, as a small error in the times of observation, would produce a considerable error in the latitude. Indeed the case may occur when FD, EL are less than $30''$, that it may be uncertain whether the points F, L, fall above or below the line DE, because the error of the lunar tables in latitude may sometimes be equal to $30''$. In this case the correct latitude of the moon may be found (1) By observations made at another place where the eclipse or occultation was not so central. (2) By the number of digits eclipsed, if it was a solar eclipse. (3) By the difference of declinations of the moon and star observed before and after the immersion or emersion. (4) By the meridian altitude of the moon observed the same day, whence it may be found whether the moon was north or south of her place given by the tables.

TO FIND THE LONGITUDE BY AN ECLIPSE OF THE SUN. 585

ELEMENTS OF THE ECLIPSE.	BEGINNING.	END.
Apparent times of observation	d. h. m. s. 15 22 6 18.1	d. h. m. s. 16 0 50 34.8
Estimated longitude W. from Greenwich	4 43 32	4 43 32
Supposed time at Greenwich	16 2 49 50.1	16 5 34 6.6
☉'s right ascension	5 36 50.0	5 37 18.5
Lat. of place 42° 33' 30"—Reduc. Tab. XXXVIII. 11' 26"	42 22 4	
Obliquity of the ecliptic	23 27 48	
☾'s long. by N. A.—Err. Tab. 58'.5—True long. ☾ Prob. I.	83 49 3.5	85 29 32.6
Longitude of the Nonagesimal, by Prob. IV.	63 22 31	86 28 36
☾'s true long.—Long. Nonages.—☾'s dist. from Nonages	20 26 32	350 2 57
This distance or supp. if greater than 180° is arch D.	D 20 26 32	D 9 57 3
Altitude of Nonagesimal Prob. IV.	67 58 0	70 57 46
☾'s horizontal parallax, by Prob. I.	60 24.1	60 27.0
☉'s hor. par. 8''.8—Correction, Table XXXVIII. 5''.6	— 14.4	— 14.4
Reduced parallax	60 9.7	60 12.6
☾'s S. Diam. by N. A.—Inflexion 2'	16 25.7	16 26.4
Add correction Table XLIV.	15.2	16.4
☾'s corrected semi-diameter	16 40.9	16 42.8
☉'s semi-diameter by N. A. 15' 46''.1—Irradiation 3''.5	15 42.6	15 42.6
Sum of the corrected semi-diameters	SF= 32 23.5	SL= 32 25.4
☾'s horary motion in longitude by Problem II. Ex. II.	36 39.2	36 42.8
☉'s horary motion	2 23.1	2 23.1
☾'s horary motion from the sun*	34 16.1	34 10.7
☾'s parallax in longitude P	19 46.8	10 0.0
☾'s apparent longitude—Error Tab. 58''.5, by Prob. V.	84 8 50.3	85 19 32.6
☾'s longitude by Problem I.	84 41 3.4	84 47 35.5
Diff. ☾'s app. longitudes=☾ app. mot.		1 10 42.3
Diff. ☉'s longitudes=☉ app. mot.		6 32.1
Difference of motions of ☉ ☾		FA 64 10.2
☾'s true lat. by N. A. Prob. I.—Error Tab. 11''.4	— 24 27.4	— 15 10.4
☾'s app. lat. cor. for error Tab. 11''.4 by Prob. V.	FD= 1 53.8	EL=+ 4 32.5
☾'s lat. at end—Lat. at beginning		AL=+ 6 22.3

As the apparent latitude at the beginning of the eclipse is north, and at the end south, the point F corresponding to this example falls above DE, the point L below it. The rest of the calculation is as follows.

FA 64' 10".2=3850'.3 log. 3.58548	☉'s longitude	24° 41' 3".4
AL 6 22.3 = 383.3 log. 2.58917	SD	— 32 23 .5
Inclination 34° 14' tan. 10.99631 co-s. 10.00220	☾'s app. long.	84 8 39 .9 by obs.
Apparent motion FL 3859.7 log. 3.58768	☾'s par. long.	— 19 46 .8
Its arith. comp. 6.41232	☾'s true long.	83 48 53 .1
SF + SL=64' 48".9 3838.9 log. 3.58938	☉'s long.	84 41 3 .4 const. 3.55630
Diff. SF, SL 1.9 log. 0.27875	Diff. 3130'.3 = 52 10 3 log. 3.49358	
Diff. segments 1.91 log. 0.28090	☾ hor. mot. fr ☉ 34' 17''.1=2057''.1 AC 6.68675	
Its half 0.95	Time fr. conj. 1h 31' 18''.1=5478''.1 log. 3.73963	
Half of FL 1934.85	App. ti. obs. 15 22 6 18.1	
Sum is great segment 1935.8	An. ti. conj. 15 23 37 36.2 at Salem	
Diff. is lesser seg. FB 1933.9 log. 3.28844	Conjunct. 16 4 19 at Greenwich	
SF 32' 23".5= 1943.5 log. 3.28858	Diff. Merid. 4 41 23.8	
Angle FBB 34° 19' sine 9.99796		
Inclination 34 14		
Diff. cent. ang. DSF 0.5 co-sin. 10.00000	..... sine 7.16270	
SF 3.28858	..... sine 3.28858	
SD=32' 23".5 = 1943.5 log. 3.28858	App. lat. FD=2'.8 log. 0.45128	

In finding the time of conjunction or new moon, at Greenwich, 4h. 19', in the Nautical Almanac, the longitude of the moon was supposed to be given correctly by the tables. If the calculation be made by Problem III. after allowing for the error—58''.5, the result will be 4h. 20' 47'', whence the difference of Meridians=4h. 43' 10''.8, which differs so little from the assumed longitude 4h. 43' 32'', that it will not be necessary to repeat the operation. If the eclipse was observed at Greenwich, the time of conjunction ought to be determined thereby, in a similar manner to the above calculations; or by those of Problem VIII. if only one of the phases is observed: by this means the errors of the tables will be wholly avoided. If the eclipse was not observed at Green-

* This horary motion increases from 34' 16''.1 to 34' 19''.7 or 3''.6, during the eclipse 2h 44' 16''.5, which is 1''.32 per hour. Now the ecliptic conjunction, or time of new moon at Greenwich by the N. A. was 4h. 19' or rather 4h. 20' 47'', corresponding to 23h. 57' 15'' at Salem, which is 1h. 30' 57'' after the beginning of the eclipse: and the increase of the horary motion in half that time is 1'', which added to 34' 16''.1, gives the horary motion 34' 17''.1, corresponding to the middle time between the beginning of the eclipse and conjunction. This is used in calculating the correct time of conjunction.

wich, the observations at any other place whose longitude is known might be made use of, and thus the difference of meridians accurately obtained.

The moon's true longitude deduced from the above observation, is $83^{\circ} 48' 53''.1$; by the N. A. it is $83^{\circ} 50' 2''.0$, the difference— $65''.9$ would be the error of the tables by this observation, if the assumed longitude $4h. 43' 32''$ and the solar tables were correct. By repeating the operation with the assumed longitude $4h. 43' 10''.8$ the error $68''.9$ would be reduced to nearly the estimated value $59''.5$.

The eclipse was so nearly central at Salem, that a variation of a minute in the moon's latitude, would hardly alter the times, or duration of the eclipse, so that the latitude could not be determined by the above observations to any considerable degree of accuracy. From this cause it happens that the app. latitude at the beginning of the eclipse is by the above calculation $2''.8$ instead of $1' 55''.8$, as found by allowing the error $11''.4$, deduced from other observations made where the eclipse was not so nearly central, and by the limits of the shadow of total darkness.

PROBLEM VII.

Given the latitude of the place, and the apparent times of the beginning and end of an occultation of a fixed star by the moon, to find the longitude of the place of observation.

In the following rule reference will be made to fig. 13, Plate XII. in which DSE represents a parallel to the ecliptic passing through the place of the star S; SF, SL the corrected semi-diameters of the moon at the beginning and end of the occultation; DF, EL the differences between the apparent latitudes of the moon and the star, when of the same name, or their sums when of different names; either of these lines falling below DE if the moon's apparent latitude is more southerly than that of the star, otherwise above.

RULE.

To the apparent times of the beginning and end of the occultation add the estimated longitude of the place in time if it is *west*, but subtract if *east*; the sum or difference will be the supposed time at Greenwich, corresponding to which, in the Nautical Almanac, find by Problem I. the moon's semi-diameter, horizontal parallax, longitude and latitude,* and the sun's right ascension; also the moon's horary motion by Problem II. and the true longitude and latitude of the fixed star, by Table XXXVII. corrected for aberration and equation of equinoxes by Tables XL. XLI. Find also in the N. A. the obliquity of the ecliptic. To the moon's semi-diameter, add the correction in Table XLIV.† and from the sum subtract the inflection $2''$, the remainder will be her corrected semi-diameter. With these elements and the apparent times at the place of observation, calculate the altitudes and longitudes of the Nonagesimal, by Problem IV. and the parallaxes in longitude and latitude, and the moon's apparent longitudes and latitudes by Problem V.

Take the difference between the *apparent* longitudes of the moon at the beginning and end of the occultation, which will be the moon's *apparent* motion in longitude, the logarithm of which, in seconds, being added to the log. co-sine of the *mean*‡ of the apparent latitudes of the moon at the beginning and end of the occultation, rejecting 10 in the index, will be the logarithm of the motion of the moon on the parallel FA. The relative motion in latitude AL, is found by taking the difference of the moon's *apparent* latitudes at the beginning and end of the eclipse if they are both north or both south; but their sum if one be north and the other south. From the logarithm of FA, increasing the index by 10, subtract the logarithm of AL, the remainder will be the log. tangent of the *angle of inclination* DSB; this angle is to be taken *greater* than 90° when the difference of the moon's and star's apparent latitudes at the beginning of the occultation FD is *greater* than at the end EL, otherwise *less*.§ Then to the log. co-secant of the angle of inclination, add the logarithm of the relative motion FA, the sum, rejecting 10 in the index, will be the logarithm of the apparent motion of the moon in her orbit FL.

Then in the triangle SFL, the sides SF, FL (representing the corrected semi-diameters of the moon at the immersion and emersion,) and the relative motion FL are given to find the angle FSB (by Case VI. Oblique Trig.) Thus: to the log. ar. ca. of FL, add the log. of the sum of SF and SL, and the log. of their difference, the

* Corrected for the errors of the tables in longitude and latitude, when known.

† This correction must be found after the altitude and longitude of the nonagesimal are calculated.

‡ The mean latitude is half the sum of the two latitudes, if they are of the same name, but their half difference, if of different names. In solar eclipses, the correction for the mean latitude of the moon is neglected as too small to be taken notice of, the distance FA being taken equal to the difference of longitude DE (fig. 12, P. XII.)

§ This rule is equally true whether the points F, L fall on the same or on different sides of the line DE. If DF, EL are equal, and the points F, L fall on the same side of DE, the angle DSB will be 90° . If they are equal, and those points fall on different sides of the line DE, the angle DSB may be taken acute or obtuse. In strictness when the points F, L fall on different sides of DE, the angle DSB is

greater or less than 90° , according as the quantity $\frac{FD}{SF}$ is greater or less than $\frac{EL}{SL}$

3rd. Rejecting 10 in the index, will be the log of the difference of the segments FB, Bl., half of which added to, and subtracted from half of BL, will give the two segments FB, Bl., the greater segment being contiguous to the greater side, whether SF or SL. Then from the logarithm of the segment FB, increasing its index by 10, subtract the logarithm of SF, the remainder will be the log. sine of the angle FSB, which is always less than 90°. The difference between this and the angle of inclination DSB, will be the central angle DSF.

To the log co-sine of the central angle, and the logarithm of the moon's corrected semi-diameter at the immersion SF, and the log secant of the star's latitude, the sum, rejecting 20 in the index, will be the logarithm of the apparent difference of longitude of the moon and star at that time. This is to be subtracted from the true longitude of the star, if the central angle is less than 90° , but added if greater than 90° , the sum or difference will be the moon's apparent longitude. To this must be added the moon's parallax in longitude, when her distance from the Nonagecimal point as a Problem 5 by subtracting the longitude of the Nonagecimal from the moon's longitude, borrowing 360 when necessary) is greater than 180° , otherwise the parallax must be subtracted, the sum or difference will be the moon's true longitude at the beginning of the occultation.

Take the difference in seconds between the true longitudes of the star and moon at the beginning of the occultation, to the logarithm of which, add the arithmetical comp. log. of the moon's horary motion in seconds, and the constant logarithm 3.5610, the sum, rejecting 10 in the index, will be the logarithm of the time from the conjunction in seconds, which is to be added to the observed apparent time of the beginning of the occultation, when the star's longitude is greater than the moon's true longitude at that time, otherwise subtracted, the sum, or difference, will be the apparent time of the true ecliptic conjunction of the star and moon at the place of observation. The difference between this and the time of conjunction, inferred from the Nautical Almanac by Problem III. for the meridian of Greenwich, will be the longitude of the place. If corresponding observations be made at different places, it will be much more accurate to deduct from them the time of conjunction at each place, and take the difference of those times for the difference of meridians if it does not differ much from the supposed difference of longitude. If there is considerable difference, the operation must be repeated, making use of the longitude found in this operation and thus by successive operations the true longitude may be obtained.

The long. of the place of observation being accurately known, the errors of the lunar tables in lat. and long. may be easily found. For the difference between the moon's true longitude, deduced from the observations by the above method, and the longitude found from the Nautical Almanac, will be the error of the tables in longitude. To find the error in latitude proceed thus: To the log. sine of the central angle D⁵F, add the logarithm of the corrected semi-diameter of the moon at the instant in S⁵F, the sum, rejecting 10 in the index, will be the logarithm of the apparent difference of latitude of the moon and star, which added to the true latitude of the star, with the sign + if the point F falls below the line D⁵F, but with the sign - if above, will give the apparent latitude of the moon at that time, the difference between this and the apparent latitude found by Problem 4. will be the error of the tables, always supposing the sign + to be prefixed to southern latitudes, the sign - to northern, and noting the signs as in algebra.*

REMARKS.

In the two preceding Problems the time of the true conjunction is calculated by means of the triangle SFD, but it will be useful for the purpose of verification, to go over the calculation by means of the triangle SLE. The process is nearly the same in both methods. The difference consists in finding the angle LSB by subtracting the logarithm of SL from the logarithm of LE, increasing its index = 10, the remainder will be the log. sine of the acute angle LSB, which, added to the angle of inclination, (found as before) will give the central angle DSL, with which and the distance SL corresponding to the end of the eclipse or occultation may be found the apparent diff. of longitude between the sun and moon, and moon and star, this is to be added to the longitude of the sun or star at that hour, if the central angle exceed 90° otherwise subtracted the sum or difference will be the apparent longitude of the moon corresponding from which the time of the eclipse or conjunction may be obtained as before. If the central angle exceed 180° the sine and cosine of the excess of that angle above 180° must be found instead of the sine and cosine of the central angle.

The apparatus for the calculation of the α_{ij} is based on the preceding rules for making use of the central angle (15) in the α_{ij} or β_{ij} correspondingly to the end of the sequence of calculation, whence may be deduced the apparatus for the calculation of the values of α_{ij} and β_{ij} .

[illegible]

* When the variable, it must be taken to correspond to the middle time between the immersion and the observation.

EXAMPLE.

Suppose in a place in the latitude of 20° 0' N. longitude 1h. 9m. 0s. east of Greenwich by estimation the occultation of Spica by the Moon on Dec. 12, 1802, was observed; the immersion at 16h. 57' 29", emission at 18h. 10' 29", apparent time by astronomical computation. Required the longitude of the place of observation?

Most of the elements in the following Table are calculated by Problems I. II. and VI.

ELEMENTS OF THE OCCULTATION.			IMMERSION		EMERSION	
			d. h. ' "		d. h. ' "	
Apparent times of observation			12 16 57 29		12 18 10 29	
Estimated longitude E. from Greenwich			1 9 0		1 9 0	
Supposed time at Greenwich			12 15 48 29		12 17 1 29	
☉'s right ascension			17 20 59.0		17 21 12.5	
Lat. of place 20° 0'—Reduc. Tab. XXXVIII. 7' 22"			19° 52' 38"			
Obliquity of the ecliptic			23 27 39			
D's long. by N. A.—Prob. I.			200 7 56.3		200 51 36.1	
Longitude of the Nonagesimal, by Prob. IV.			149 15 55		165 28 58	
D's long.—Long. Nonages.—D's dist. from Nonages			50 52 1		35 22 38	
This distance or its supp. to 360° is arch D.		D	50 52 1	D	35 22 38	
Altitude of Nonagesimal Prob. IV.			81 17 32		74 55 13	
D's horizontal parallax			59 52.3		59 54.4	
—Reduction, Table XXXVIII.			1.4		1.4	
Reduced parallax			59 50.9		59 52.8	
D's S. Diam. by N. A.—Inflexion 2'			16 16.9		16 17.5	
Add correction Table XLIV.			10.4		13.5	
D's corrected semi-diameter		SF	16 27.3	SL	16 30.9	
D's horary motion in longitude by Problem II. Ex. I*.			35 51.7		35 54.2	
D's parallax in longitude			46 25		35 54	
D's apparent longitude			200 54 21.3		201 25 30.1	
Difference of D's app. longitudes					31 2.8	
D's true lat. by N. A. Prob. I.		South	1 55 11.0		1 54 29.1	
D's parallax in latitude			10 28.6		17 32.6	
D's apparent latitude South			2 5 34.6		2 9 7.9	
*'s tr. lat.= lat. T. XXXVII. 2° 2' 13". S.—T. XLI. 0'. 6			2 2 18.3		2 2 13.3	
Difference D * app. lat.		FD=	3 21.3	KL=	6 54.3	
Difference of D's app. latitudes				AL=	3 32.9	
*'s tr. long.=Long. Tab. XXXVII. 201° 10' 29". S.—Tab. XL. 11'. 5—Tab. XLI. 10'. 1.			201 10 30.7			

The difference of the apparent latitudes of the Moon and Star at the beginning of the occultation 3' 21".3 being less than at the end 6' 54".2 the angle of inclination is less than 90°. In this example the moon's latitude is more southerly than the star's, hence the points F, L, fall below the line DE.

Diff. app. long. D	31' 8" 8=1868".8	log.	3.27156			
D's mean app. lat.	2 7 21	cos.	9.99970			
Distance FA		log.	13.27126			3.2713
D's diff. lat.	AL=3 32.9=212 .3	log.	2.32318			
Inclination	83° 30'	tan.	10.91508		co-secant	10.0000
Apparent motion FL	1879 .6					3.2745
Its arith. comp.			6.72594			
SF + SL	= 32 53.1 = 1978 .1	log.	3.29625			
Diff. SF, SL	3 .5	log.	0.54407			
Diff. segments	3 .7	log.	0.56626			
Its half	1 .8					
Half	FL	939 .8				
	FB	936 .0	log.	2.97220		
	SF	987 .3	log.	2.99445		
	FSB	71° 49'	sine	9.97775		
Inclination	83 30					
Diff. is cent. angle	11 41	co-sine	9.92091		sine	9.3663
	SF	log.	2.99445			2.9945
Star's lat.	2° 2' 13"	sec.	10.00027			
Diff. app. long. D *	967".5 = 16 7.5	log.	2.98563	FD 199".9=	3' 19".3 lon.	2.5004
* longitude	201 10 30.7			* lat.	2 2 13 .3	
D's app. long.	200 54 23.2	by obs.		D's ap. lat.	2 5 33 .2 by obs.	
D's par. long.	— 46 25			D's ap. lat.	2 5 34 .6 by N. A.	
D's true long.	200 7 58.2	const.	3.55630	Error Tab.	— 1 .4 in lat.	
Diff. true long.	3752.5= 1 2 32.5	log.	3.57432	D's tr. lon.	200 7 58 .2 by obs.	
D's hor. mot.	2153.5 35 53.5	log.co-ar.	6.66686	D's tr. lon.	200 7 56 .3 by N. A.	
Time	6273 1 44 33	log.	3.79748	Error Tab.	+ 1 .9 in long.	
Immersion	16 57 29					
Conjunction	18 42 2 at place of observa-					
Conjunction	17 33 0 tion at Greenwich.					
Diff. of meridians	1 9 2					

* The moon's horary motion varies from 35' 51".7 to 35' 54".2 during the occultation, hence at the middle time 17h. 49' 45" between the immersion 16h. 57' 29" and the conjunction 18h. 42' (deduced from the Nautical Almanac) the horary motion was 35' 53".5 as is easily found by a calculation similar to that in the Example of Problem VI.

The difference of meridians deduced from the observation 15^h 9' 2" differs but 2' from the assumed quantity 15^h 4' 0". If the difference had been considerable, it would have been necessary to repeat the operation with the difference of meridians thus calculated, and so on till the assumed and calculated longitudes agree. The errors of the tables above found were deduced upon the supposition that the observations were actually made at the place mentioned in this example, and that the true longitude of the place of observation was 15^h 4' 0". For it must be observed that the errors of the tables in longitude cannot be found by an observation of an eclipse or occultation without knowing by other observations the precise longitude of the place of observation. This is evident by observing, that by repeating the operation till the assumed and calculated longitude of the place of observation agree with each other, the long. of the moon, deduced from the calculation, will agree also with the longitude by the tables. The time of conjunction at Greenwich 15^h 34' 0" taken from the Nautical Almanac, is liable to a small error from the incorrectness of the tables. To obviate this error it will be necessary to reduce (by the above method or by Problem IX when only the beginning or end is observed) the time of conjunction from observations actually made at two places, the difference of these times will be the difference of meridians free from the errors of the tables.

PROBLEM VIII.

To find the longitude of a place by an eclipse of the sun when the beginning or end only is observed, the apparent time being estimated from noon, according to the method of astronomers, the latitude of the place being also known

RULE

To the apparent time apply the estimated magnitude of the place in time, by adding it east, and subtracting it west, the sum or difference will be the apparent time at Greenwich. Corresponding to this time in the Nautical Almanac find by Problem I the true mean anomaly and also the parallax in right ascension, and let u , u' and the true sun in longitude and right ascension be u and u' also the moon's mean longitude fix to the sun & P and H be arcs 30 days and u greater and u' less than u . Decrease the former u calculated for addition and fix the remainder u' to the former u' in the Table XIIV the result will be the moon's corrected longitude. For place in longitude at λ hours, the obliquity of the ecliptic.

With these elements and the apparent line of the plane of observation calculate the latitude λ according to (1) of the nonagesimal by P. obtain IV and the parallaxes in longitude μ and latitude ν of the moon's apparent latitude by P. item V.

To the sum of the corrected orbital diameters of the sun and moon add or subtract the moon's apparent latitude, and find the sum or difference of the sun and difference in seconds. Then the sum of these two logarithmic values will be the logarithm of an arc which may be added to the sun's true altitude if the planet is under the ecliptic or subtracted from it if above; the number of degrees will be the apparent longitude in the zodiac. To find the moon's parallax at night when the moon's distance from the horizon is not found as in Problem V by subtracting her logarithm of the cosine, etc., from the sun's logarithm of secant, etc., when it comes to greater than 90°, and remain unaltered when it differs less than 90°.

[illegible]

EXAMPLE

*At Salem, in the latitude of $42^{\circ} 13' 30''$ N longitude by estimation $71^{\circ} 45' 32''$ W from Greenwich the beginning of the total eclipse of June 1800 was observed at 1^h 24^m 6^s 1st apparent time by astronomical computation. Required the longitude of the place from this observation.

The formula must be calculated as in example of Pt. 100.44 for the logging of the escape except those marked in italics. The rest of the calculation may be made by proportional logarithms as follows:

* The longitude now listed must be corrected for the errors of the tables when taken by a previous operation or by other observations.

† This correction must be found *after* the altitude and longitude of the nonagesimal are calculated.

* These calculations may be made to the same number by using logarithms of logarithms, the only difference consists in using the constant logarithm 2.471 instead of 2.52436 in finding the time of construction.

4 In general the beginning of an eclipse or occultation precedes the apparent conjunction and the end is after the apparent conjunction but there is a case (which very rarely occurs) where the contrary may take place, namely where the point B or C is XII fig. 1. In this case between C and B which can happen only in the case of BC are nearly equal to $AB + AC$. In this case it may be ascertained whether the phase precedes or follows the conjunction by making the calculations as in Prop. VI or VII with the values of μ and ρ as calculated by Problem XII and as the central angle is greater it is then that W the phase will follow precede in the apparent conjunction. The intervals given for the future being supposed to be 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799,

Sum semi-diam. ☉ D	32' 23'' .5		
D App. lat.	1 55 .8		
Sum	34 19 .3	P. L.	0.7197
Diff.	30 27 .7	P. L.	0.7716
		Sum	1.4912
Half sum	Arch 32 20	P. L.	7456
☉ Longitude	84 41 3 .4		
D App. long.	84 8 43 .4		
D Par. long.	— 19 46 .8		
D True long.	83 48 56 .6		
☉ True long.	84 41 3 .4	Cons. log.	0.4771
Difference	52 6 .8	P. L.	0.5323
D Hor. mot. fr. ☉	31 17 .1	A Co. P. L.	9.2798
Time from conj.	1h. 31' 15''	P. L.	0.2452
App. time obs.	15 22 6 18		
App. conj. Salem	15 23 37 31		
App. conj. Green.	16 4 19 by N. A.		
Diff. Merid.	4 41 29		

If we suppose the time of conjunction at Greenwich to be 4h. 20' 47", as calculated in the *example Problem VI.* the difference of meridians would be 4h. 43' 16", agreeing nearly with the assumed longitude, so that it will not be necessary to repeat the operation. The remarks at the end of that example respecting the errors of the lunar tables, and the comparing of actual observations at different places are equally applicable to the present Problem.

PROBLEM IX.

To find the longitude of a place by an occultation of a fixed star by the moon, when the immersion or emersion only is observed, the apparent time being estimated from noon to noon, according to the method of astronomers, and the latitude of the place being known.

RULE.

To the apparent time apply the estimated longitude of the place turned into time, by adding if west, subtracting if east, the sum or difference will be the supposed time at Greenwich. At this time find in the Nautical Almanac the sun's right ascension, the moon's semi-diameter, horizontal parallax, longitude and latitude * by Problem I. and the moon's horary motion by Problem II. also the latitude and longitude of the fixed star by Table XXXVII. and correct it for aberration and equation of equinoxes by Tables XL. XLI. Decrease the moon's semi-diameter 2" for inflexion, and to the remainder add the augmentation from Table XLIV. † the sum will be the *corrected semi-diameter*. Find also, in the Nautical Almanac, the obliquity of the ecliptic. With these elements and the apparent time of observation, calculate the altitude and longitude of the Nonagesimal by Problem IV. also the parallaxes in longitude and latitude of the moon's apparent latitude by Problem V.

Take the difference between the latitude of the star and the app. lat. of the moon, which add to, and subtract from the moon's corrected semi-diameter (these quantities being expressed in seconds) half the sum of the logarithms of these quantities increased by the log. secant of the star's latitude, rejecting 10 in the index, will be the logarithm ‡ of an arch in seconds to be added to the star's longitude if the moon has passed the apparent conjunction, but subtracted if *before*, § the sum or difference will be the *apparent longitude* of the moon. To this add the moon's parallax in longitude when the moon's distance from the nonagesimal (found as in Problem VII. by subtracting the longitude of the nonagesimal from the moon's longitude, borrowing 360° when necessary) is greater than 180°, otherwise subtract it, the sum or difference will be the *true longitude* of the moon. Take the difference in seconds between the moon and star's true longitudes, and to its logarithm add the arithmetical comp. log. of the moon's horary motion and the constant logarithm 3.55630, the sum, rejecting 10 in the index, will be the logarithm ‡ of a correction in seconds to be applied to the given time of observation by *adding* when the moon's true longitude is less than the star's, otherwise *subtracting*, the sum or difference will be the time of the true conjunction at the place of observation. The difference between this and the time of conjunction inferred from the Nautical Almanac by Problem III. for the meridian of Greenwich, will be the longitude of the place of observation, if the tables are correct; but it is much more accurate to compare the times of conjunction deduced

* Corrected for the errors of the tables in longitude or latitude when known.

† This correction must be found after the altitude and longitude of the nonagesimal are calculated.

‡ See note with this mark in page 589.

§ Proportional logarithms may be used instead of common logarithms, the constant logarithm being 0.4771 instead of 3.55630, and the log. co-sine being used instead of log. secant.

from actual observations at the different places in the manner mentioned at the end of the rule given in Problem VII.

EXAMPLE.

Suppose in a place in the latitude of $20^{\circ} 0'$ N. longitude by estimation $1\text{h. } 9' 0''$ east from Greenwich, the emersion of the star Spica was observed on December 12, 1806, at $18\text{h. } 10' 29''$, apparent time by astronomical computation. Required the longitude of the place of observation?

The elements must be calculated as in the example of Problem VII. for the emersion of Spica. The rest of the calculation, made by common logarithms, is as follows.

☽ Semi-diameter	16 50 .8 = 500 .8				
Diff. app. lat. ☽ *	6 54 .2 = 414 .2				
Sum	1405 .0	log.	3.14776		
Difference	576 .6	log.	2.76087		
Sum	570855	its half		2.95427	
		* lat. $2^{\circ} 2' 13''$	sec.	10.00027	
Arch	15 0 6		log.	2.95454	
* longitude	201 10 30 .7				
☽ app. long.	201 23 31 .3				
☽ par long.	35 54				
☽ true long.	200 51 57 .3	Constant	3.55690		
Diff. true long. ☽ *	13 53 .4 = 1133.4	log.	3.05439		
☽ horary motion	55 54 .7 = 2151.7	co. log.	6.66621		
Time	51 51 = 1834	log.	5.27712		
Time of obs.	18 10 29				
Conj. at place obs.	12 42 3	by obs.			
Conj. at Greenwich	17 53 0	by N. A.			
Difference merid.	1 9 3				

The difference of meridians by calculation $1\text{h. } 9' 3''$ differs but $3''$ from the assumed longitude, so that it will not be necessary to repeat the operation. All the remarks made at the end of the example in Problem VII. are applicable to this problem. It may also be further observed, that the emersion or immersion which happens on the dark limb of the moon can be observed with much more accuracy than on the enlightened limb; because the light from this limb prevents the observer from perceiving the star's immersion or emersion so instantaneously as on the dark side of the moon.

PROBLEM X.

To calculate an eclipse of the moon.

The time of beginning or end of a lunar eclipse at any place may be found by subtracting or adding the longitude to the times given in the Nautical Almanac for the meridian of Greenwich, according as the longitude is west or east. But as some readers may wish to know the method of deducing these times from the longitudes, latitudes, &c. of the moon and sun, given by the Nautical Almanac or by other tables, it was thought proper to insert the rule for these calculations.

An eclipse of the moon can only happen at the time of the full moon. If her longitude at that time is not distant from either node* of the moon's orbit more than about 12° , there may be an eclipse. To find whether there will be one, and to calculate the times and phases, proceed as follows.

RULE.

Find the time of full moon at Greenwich by the Nautical Almanac or Problem III. to which add the longitude of the place turned into time if east, but subtract if west, the sum or difference will be the time of the ecliptic opposition at the proposed place.

For the time at Greenwich find by Problem I the moon's latitude, horizontal parallax and semi-diameter (which requires no augmentation) also the sun's semi-diameter. Then by Problem II. the horary motion of the moon from the sun in longitude, and the moon's horary motion in latitude.

Draw the line ACB (Plate XII. fig. 6) and perpendicularly thereto the line PCR. Select a scale of equal parts to measure the lines of projection, and from it take CG equal to the moon's latitude, and set it on CR from C to G, above the line AB if the latitude of the moon is north, below if south.† Take CO equal to the horary motion of the moon from the sun in longitude, and set it on the line CB to the right of

* The longitude of the moon's ascending node is given in the third page of the Nautical Almanac. The longitude of the other node is found by adding or subtracting $6^{\circ} 41' 46''$.

† The northern latitudes found by Prob. I. have the sign —, the southern +. In the figure the latitude is south. If it had been north the point G must have been placed on the continuation of CR above C.

C, from C to O. Take CP equal to the moon's horary motion in latitude, as found with its sign by Problem II. and set it on the line CR from C to P, *above* the line AB if its sign is —, *below** if +. Join OP which is equal to the horary motion of the moon from the sun, and parallel thereto through G draw the relative orbit of the moon from the sun NGL, on which are to be marked the places of the moon before and after the full, by means of the horary motion OP, so that the moment of full moon, or ecliptic opposition at the proposed place, may fall exactly on the point G. This may be done by making the extent OP equal to the transverse distance of 60, 60, on the line of lines of the sector, then measuring from the same lines the transverse distance corresponding to the minutes and parts of a minute in the time of full moon at the place of observation, and setting it on the line GN from G towards the right to the point x, where the whole hour preceding the full moon is to be marked.† Then the distance OP set from x to the right hand on the line LGN reaches to the hours preceding the full moon, and set to the left hand reaches successively to the following hours. These intervals are to be divided into sixty equal parts representing minutes, if the size of the scale will admit of it.

Add 50' to the moon's horizontal parallax‡ and from the sum subtract the sun's semi-diameter, the remainder will be the semi-diameter of the shadow CB, with which describe the circle ASB about the centre C. Add the moon's semi-diameter to the radius CB, and with that radius describe, about the centre C, the circle DRM, which if there be an eclipse will cut NL in the points E, H, representing respectively the places of the moon at the beginning and end of it. If there is no intersection there will be no eclipse. Draw the line CKST perpendicular to LN, cutting it in K and meeting the circles ASB, DRH in S, and T. With a radius equal to the moon's semi-diameter describe about the centres E, H, K, the small circles represented in the figure; of which that drawn round K cuts the line CKS in the points I, F, and if the eclipse is total the whole of this circle will fall within ASB, as in fig. 6, but if part of the circle falls without ASB, as in fig. 7, P. XII. the eclipse will be partial. In either case the number of digits eclipsed may be obtained by saying as the diameter of the moon FI is to the obscured part FS so are 12 digits to the number of digits eclipsed. When the eclipse is total, the beginning and end of total darkness may be found by taking a radius equal to CB decreased by the moon's semi-diameter, and sweeping with it round the centre C, a circle *d e h m*, cutting LN in the points e, h, representing respectively the points of beginning and end of total darkness. Then the hours and minutes marked in the line NL, at the points E, e, K, h, H, will represent respectively the times of the beginning of the eclipse, beginning of total darkness, middle of the eclipse, end of total darkness, and end of the eclipse. In this rule no allowance is made for the oblate figure of the earth, the correction from this source being much less than the errors of observation.

EXAMPLE.

Required the times of beginning, end, &c. of the eclipse of the moon of May 9th, 1808, at a place in the longitude of 30° W. from Greenwich?

By the Nautical Almanac the time of full moon at Greenwich was May 9th, at 19h. 39'. From this subtracting the longitude of the place of observation 30° W. or 2h. the remainder 17h. 39' was the time of full moon at the place of observation. Corresponding to the time at Greenwich, 19h. 39', the elements in the adjoined table were calculated by Prob. I. and II. and the values CB, CD, Cd, found by the above rule. Upon the centre C with the radii CB, CD, Cd, taken from a scale of equal parts, describe the circles ASB, MRD, *mrd*. Draw the line ACB representing the ecliptic, and

Elements of the Eclipse May 9. 19h. 39'.		
App. time conj. Greenwich, May 9		19h. 39'
Long. place 30° W		2 0
App. time conj. at place obs.		17 39
☾'s lat. by Prob. I. S. decreasing	OG +	10 44.4
☾'s Horiz. Paral.		61 13.5
☾'s Semi-diameter	BD	16 00.7
☉'s Semi-diameter		15 51.3
☾'s Hor. Mot. in long. Prob. II.		37 37.4
☉'s Hor. Mot. in long.		2 34.4
☾'s Hor. Mot. from ☉ in long.	CO	35 13.4
☾'s Hor. Mot. in lat. Prob. II.	CP -	3 29.2
☾'s Hor. Par. + 50' - ☉'s S. D. = CB		46 12.5
CB + ☾'s S. D. = CD		62 32.9
CB - ☾'s S. D. = Cd		29 31.5

* In other words the point P will fall above C if the moon is approaching to the north pole of the ecliptic, otherwise below: That is, the point P must fall *above* C if the moon's latitude is *south decreasing* or *north increasing*, otherwise below. When no great accuracy is required the horary motion in latitude need not be found by Prob. II. Instead of which the angle COP may be taken equal to 5° 40', in eclipses of the moon or sun, and the line OP equal to CO increased by 9' or 10': but this method will not answer in occultations, in which the angle COP varies above 5 degrees.

† The distance Gx may also be found by common arithmetic by saying as 60 minutes are to the minutes and seconds in the time of full moon (which in the present example is 39) so is OP to Gx. After marking the hours on the line LGN it is usual to divide them successively into halves and quarters of an hour, then into five minutes and one minute.

‡ The semi-diameter of the shadow is increased by the earth's atmosphere from 20' to 60', according to the estimates of different astronomers. Mayer supposes this correction to be one 60th part of the shadow, varying from 37' to 46". The mean of Mayer's correction added to the sun's parallax is nearly equal to 50' assumed as above.

make CG perpendicular thereto equal to the moon's latitude $10^{\circ} 41'$ S. the point G being taken below C because that latitude is south. Make CO equal to the horary motion of the moon from the sun in longitude $35^{\circ} 13'$, and CP perpendicular thereto equal to the horary motion in latitude $3^{\circ} 28'$, the point P being placed above C, because the moon's horary motion in latitude has the sign prefixed, or in other words, the latitude was south decreasing. Join P, and parallel thereto draw through G the line DGL, and on it let fall the perpendicular CK. Make the distance OP a transverse distance of 60, 70, on the line of lines of the sector and measure from the same lines the transverse distance 23, 24 corresponding to the minutes of the time of full moon at the place of observation: this distance, set on the line CN, to the right of G, reaches to the point x, where the hour 17h preceding the full moon is to be marked. Take the extent OP and lay it from 17h to the right hand to 16h and successively to the left to 18h, 19h &c. Subdivide these lines into 60 equal parts representing minutes, if the scale will permit, and the times corresponding to the points F, x, K, h, H, will represent respectively the beginning of the eclipse 15h 46m, the beginning of total darkness 16h 7m, the middle of the eclipse 17h 11m, the end of total darkness 18h 28m, and the end of the eclipse 19h 26m which times agree nearly with those in the Nautical Almanac, allowing for the difference of meridian 2 hours.

Calculation by Logarithms.

The phases of the eclipse may also be calculated by logarithms in a very simple manner. Thus suppose it was required to find the time of the beginning of the eclipse in the above example. In this case in the right-angled triangle C P, there would be given $\angle C = 2113^{\circ}$ and $CP = 20^{\circ} 2'$, and $OP = 2123^{\circ} 2'$ and the angle $OPC = 84^{\circ} 22'$. This angle is equal to RGE , because GE, OP are parallel, and its supplement gives the angle $\angle GCE = 95^{\circ} 38'$. Then in the triangle $\angle GCE$ there are given the angle $\angle GCE = 95^{\circ} 38'$ the moon's latitude $\angle C = 644^{\circ}$, and the line $CE (= CD) = 3772^{\circ} 9'$ to find $CEG = 9^{\circ} 48'$, $\angle GCF = 74^{\circ} 34'$ and $GE = 3551^{\circ} 5'$. Then say as $OP (2123^{\circ} 2')$ is to 1 hour ($3600'$), so is $GE (3551^{\circ} 5')$ to the time $(6196' =)$ 1h. 43' 16" between the beginning of the eclipse and the full moon at the place of observation 17h 39', and as the point E falls to the right hand of C, that time must be subtracted from 17h 39', to obtain the time of the beginning of the eclipse 15h 55' 44", which agrees nearly with the projection. As these calculations are very simple, it will be unnecessary to take notice of the different cases, or to give the calculations at full length, the whole being sufficiently evident from the figure. The middle of the eclipse is found by means of the triangle GKH similar to OPC , in which the angles and hypotenuse CG are given to find CK, KG . The time of describing KG being added to, or subtracted from the time of full moon at the place of observation, according as the point K falls to the left or right of G, will give the time of the middle of the eclipse. The distance $CK 10' 41''$ 7 subtracted from the radius CD or $CE = 62' 52''$ 9 will leave a remainder equal to the eclipsed part $FS (= KF, 52' 11''$ 2. And the moon's diameter $33' 21''$ 4 is to $FS 52' 11''$ 2 as 12 digits to the digits eclipsed $18\frac{1}{2}$. In making these calculations, common or proportional logarithms may be made use of.

PROBLEM XI

To project an eclipse of the sun for any given place.

An eclipse of the sun can happen only at the time of new moon. If the moon's longitude at that time is not distant from either node of the moon's* orbit more than $17\frac{1}{2}^{\circ}$ there may be an eclipse. To find whether there will be one, and to calculate the times and phases, proceed by the following

RULE.

To the time of the new moon given in the Nautical Almanac (or calculated by Problem III.) add the longitude of the proposed place, turned into time, if east, but subtract if west: the sum or difference will be the time of conjunction at the proposed place. Corresponding to the time of new moon at Greenwich, find by Problem I the moon's latitude, horizontal parallax, and semi-diameter, also the sun's magnitude, semi-diameter and declination. Then by Problem II, find the horary motion of the moon in latitude, and the horary motion of the moon from the sun in longitude.

Draw the line A'B (Plate XII fig. 10) representing the ecliptic and perpendicular thereto, the line C'D'R. Take a scale of equal parts to measure the lines of the projection: measure from it an interval equal to the moon's latitude, and apply it on C'D from C to G, above the line ACB if the moon's latitude is north, below, if south. Take CO equal to the horary motion of the moon from the sun in longitude and set it on the line CB to the right hand of C to O. Take CF equal to the moon's horary

* See note with this mark, page 59. All the eclipses that can happen in any part of the earth are delineated in the Nautical Almanac.

† In the figure the latitude is supposed north. If it had been as much south, the point G would have been as much below C as it is now above it.

motion in latitude, found by Prob. II. and set it on the line CR, from C to P, *above* the line ACB if the sign is —, *below* if +. Join OP which represents the horary motion of the moon from the sun on the relative orbit, and parallel to that line draw the relative orbit of the moon NGL, on which are to be marked the places of the moon before and after the conjunction, by means of the horary motion OP, so that the moment of the new moon, or ecliptic conjunction, at the proposed place may fall exactly on the point G, as in the figure where the new moon is at 23h. 35m. This may be done by taking the extent OP equal to the transverse distance of 60, 60, on the line of lines of the sector, then measuring from the same lines, the transverse distance corresponding to the minutes and parts of a minute of the time of new moon at the place of observation and setting it on the line GN from G towards the right hand to the point x, the place of the moon at the first whole hour preceding the conjunction (which in the present figure is 23h.) Then the distance OP being taken in the compasses and set from x to the right hand, gives successively the hours preceding the new moon, and the same distance set to the left gives the following hours, as in the figure, where they are marked in succession 22h. 23h. 24h. 1h. These hours are to be divided into 60 equal parts representing minutes, the scale being taken sufficiently large for that purpose. † In the present figure the subdivisions are carried only to five minutes.

From the moon's horizontal parallax subtract the sun's 8".8, the remainder is to be taken from the scale of equal parts for the radius CB, with which, on the centre C, describe the circle BRA, cutting CR in R. Open the sector till the transverse distance of 60°, 60°, on the line of chords, is equal to the radius CB, and measure from the same lines the transverse distance 23° 28' (equal to the obliquity of the ecliptic) which set on the circle ARB on each side of R to T and U. Join TU cutting CR in Q. On Q as a centre, with the radius QV, describe the circle TVU, on which set off the arch TV equal the sun's longitude. Through V draw the line VP' parallel to CR to cut TU in P', the place of the pole of the earth. § Draw CP' and continue it on either side so as to cut the circle ARB in the point W, situated *above* AB if the latitude of the proposed place is *north*, *below*, if *south*. In the present figure the latitude is north. If it had been south the lower part of the circle ARB ought to have been made use of. Open the sector so as to make the transverse distance 60°, 60°, on the chords, equal to CB, and measure off the transverse distance equal to the chord of the complement of the latitude of the place, which set from W on each side to D and d. With the same opening of the sector measure the chord of the sun's declination, and set it on the same circle from D on each side to E and E, and from d on each side to e and f. Draw the dotted lines Ef, Dd, Ee, cutting CW in l, q, n. Bisect l in r, and erect the line VI. r, XVIII. perpendicular to CW, and make r, VI. and r, XVIII, each equal to qD. Open the sector to make the transverse distance 90°, 90°, on the sines, equal to qD, and measure off the transverse distance corresponding to 15°, 30°, 45°, 60°, 75° (or 1, 2, 3, 4, 5 hours,) which set on each side of the point r, on r, VI. and r, XVIII. to the points marked with those numbers 15°, 30°, &c. Through these points draw the lines I. XI; II. X; III. IX; &c. as in the figure parallel to CW. Open the sector so as to make *rn* equal to the transverse distance of 90°, 90°, on the sines, and measure the complements of the former degrees

* See note with this mark in page 592.

† See note with this mark in page 592.

‡ The scale I generally make use of is one inch to 10 minutes, reducing the seconds to decimals of a minute. Thus 30' 36" in decimals is 50.6, which by this scale would be 5.06 inches, obtained by placing the decimal point one figure to the left.

§ This may also be found as follows. After drawing TQU, as above, open the sector till the transverse distance 90°, 90° on the sines is equal to QT, then measure from that line the extent QP' as a transverse distance corresponding to the sine of the difference between the sun's longitude and 90° or 270°. When the sun's longitude exceeds 6 signs, the point V will fall in the semi-circle below TU. This is not drawn in the figure for want of room. When the longitude exceeds 2, 4, 6, &c. signs, it will be convenient to mark on the circle TYU the points corresponding to those signs, by setting off the radius QT as a chord from T to II, from II to G, &c. and then taking from the sector the chord corresponding to the extent of the given longitude above that of the point II, G, &c. immediately preceding. Thus if the sun's longitude was 84° 44' it would be convenient to set off 90° from T to II, and 24° 44' from II, to the sought point V.

In case of not having a sector, an arch as RT may be marked off by a plane scale even when the radius CR differs from that of the scale, by drawing by Prob. VI. of Geometrical Problems, the line CT making an angle with CR equal to the proposed arch 23° 28'. The intersection of that line with the circle ARB will give the sought point T. In a similar manner the point V may be found by drawing a line QV making the angle TQV equal to the proposed arch TV. The points 15°, 30°, 45°, &c. on the line VI. r XVIII. may be found by describing on the line as a diameter, and on r as a centre, a semi-circle which is to be divided into 12 equal parts of 15° each. The dotted lines drawn through these points perpendicular to the diameter VI. r XVIII. will cut it in the sought points 15°, 30°, &c. This circle is not drawn in the proposed figure, to prevent confusion. Draw the line VI. k perpendicular to r VI. and equal to rn. Join rk cutting the lines 75° V : 60° IV, &c. in the points 1, 2, 3, 4, 5. Make the lines 15° I : 30° II : 45° III, &c. respectively equal to 75°, 1 : 60°, 2 : 45°, 3 : &c. and the sought points I. II. III. &c. will be obtained. This method may be used when the line rn is too small to be taken from the sector. The same method may be made use of in projecting an occultation by drawing tk (Fig. 8. P. XII) perpendicular to rt and equal to rn and joining rk to cut the dotted lines drawn parallel to CP in the points 1, 2, 3, &c. as above.

the transverse distances on the arcs, viz. 75, 60, 45, 30, 15, and set them on the above lines I. XI, II. X, &c. from the points of intersection with the line V I, r, XYIII. above and below that line. The points I. II III &c. so taken in this manner, will represent the situation of the spectator at the proper place at those hours, and a regular curve drawn through these points will represent his path. In marking the hours it must be observed, that the place of noon will be at the lower point *n*, if the sun's declination be north, but at the upper point, if the declination be south. The hours must be marked from noon towards the left in numerical order when completely void of the curve ending at 24h. according to the method of astronomers. In the present figure the declination is north, and the point *n* the place of noon at 12 hours. If it had been south the point *n* would have been marked 0h. and the points marked XI. X &c. would be I. II &c. respectively. The path touches the circle ADB in two points representing the points of sun rising and setting, which in the present figure are respectively 16h. 26' and 17h. 34'. These points divide the path into two parts, of which one represents the path by day, the other by night, as is evident from the hours marked on the curve. If 1 hour or any other intermediate time, may be marked in a similar manner. Thus, for the time 3h. 30' or 22. 30. Set the sine of $\frac{1}{2} \phi$ on the radius r, VI from *r* to *k* on the line r, VI, and erect the perpendicular *h* equal to the sine of $\frac{1}{2} \phi$ (which is the complement of $\frac{1}{2} \phi$) to the radius *rn*, and the point *h* will be the place of the spectator at the proposed time. In this way the halves and quarters of hours may be marked on those parts of the path where necessary. The smaller subdivisions may generally be retained to a sufficient degree of accuracy by dividing the quarters of hours into equal parts.

Take from the scale of equal parts a extent equal to the sum of the semi-diameters of the sun and moon, and beginning at *r*, or *Z*, find by transfer the point *y* of the moon's path and the point *Z'* of the path of the spectator marked with the same time and at that distance apart. That time will be the beginning of the eclipse. If no such points can be found, there will be no eclipse at the proposed place. Proceed in the same way towards the point *L* and find the points *p'*, *Z''*, at the same distance apart, the corresponding time will be the end of the eclipse. Find a true *p* of the moon's path and the point *Z* of the path of the spectator marked with the same time, at the nearest distance from each other (which will in general be at the middle time between the beginning and end of the eclipse) that time will be the middle of the eclipse. On *Z* as centre with a radius equal to the sun's semi-diameter, describe the circle whose diameter is *2a*, representing the sun's disc. About the centre *p*, with a radius equal to the moon's semi-diameter, describe the circle whose diameter is *2m*, representing the moon's disc. The part of the sun's disc that is cut off by this circle will represent the part of the sun that is eclipsed. In the example of fig. 1st the centre *p* of the moon's disc is so near that of the sun *Z* that the eclipse is nearly central, and as the moon's semi-diameter is greater than the sun's, the eclipse must be total. Under various circumstances if the two disc's semi-diameters be nearly equal, the eclipse will be annular or partial. In case of a partial eclipse the sun's disc will not be wholly covered by the moon, as in fig. 11, Plate XII. where the centres *p*, *Z*, and the lines of the sun and moon are marked with the same letters as in fig. 1st but the eclipse is in a different situation. In this case the number of digits eclipsed may be obtained by drawing a line through the centres *p*, *Z*, to meet the circle *2a* in the points *B*, *M*, *a*, and by saying as the distance *BM* (representing $2a - 2m$) is to the distance *2a* so the distance *BM* is to digits to the number of digits eclipsed. The beginning and end of total eclipses in a total eclipse are found alike, the beginning is the first of the eclipse, except in taking in the compasses the difference between the semi-diameters of the sun and moon, instead of their sum. But the points of the path of the spectator and of the moon's orbit, marked with the same time, and at the same distance from each other, will represent the positions and times of the beginning and end of total darkness. If the beginning and end of the internal contacts of an annular eclipse are found in the same manner, the only difference is that in a total eclipse, the moon's semi-diameter is greatest, but in an annular eclipse the least.

In observing the beginning of a solar eclipse, it is of some importance for the accuracy of the observation, to know on what part of the sun's limb the eclipse will begin. This is easily found by means of the projection. Thus at the beginning of the eclipse, which corresponds to the point *p'* of the moon's path and the point *Z'* of the path of the spectator, the first point of contact *g* may be obtained by drawing about the centre *p* with a radius equal to the moon's semi-diameter, a circle representing the moon's disc, about *Z* as a centre with a radius equal to the sun's semi-diameter another circle representing the sun's disc, touching the former in the point *g*

* Instead of this circle the line *p'Z* may be drawn cutting the sun's disc in the sought point *g* or *g'*.

Draw the line CZ' meeting the sun's disc in the points *a*, *c*, the point *c* being the most distant from the centre *C*. Then the circle *gac* being held between the eye of the observer and the sun, the engraved or marked side of the figure towards the eye, and the line *ca* in a vertical direction with the point *c* uppermost, will represent the appearance of the sun as viewed by the naked eye at that time, *c* will represent the upper part of the sun, *a* the lower, and *g* the point of contact. If the eclipse be observed with an inverting telescope, the contrary will be observed; that is, the part *a* must be uppermost, *c* the lowest, and *g* the point of contact will appear to the left hand of *ca*. In a similar manner the appearance of the objects may be obtained at any other part of the eclipse, but it is not necessary except at the beginning of it, where there is nothing to direct the eye of the observer.

EXAMPLE.

Required the times and phases of the total eclipse of the sun, June 16, 1506, at Salem, in the latitude of 42° 33' 30" N. and the longitude of 4h. 43m. 32s. west from Greenwich?

By the Nautical Almanac the time of new moon at Greenwich was June 16d. 4h. 19', corresponding to June 15, 23h. 35' 28", at Salem. At the time at Greenwich, 4h. 19' the elements of the eclipse were as in the adjoining table calculated by the above rule.

Draw ACB (Plate XII. fig. 10,) and perpendicular thereto the line CGR. Make CG equal to the moon's latitude 19' 37" N. taken from a scale of equal parts, the point G being above C because the latitude is north. Make CO equal to the moon's horary motion from the sun 34' 18".1, to the right hand of the point C; and CP equal to the moon's horary motion in

ELEMENTS.	
	<i>h. m.</i>
Conjunction at Greenwich, June 16.	4 19
Salem W. from Greenwich	4 43 32
Ecliptic conjunc. at Salem, June 15,	23 35 28
Latitude of Salem	42 33 30
☾'s Horizontal Parallax	60 25.7
☾'s Horizontal Parallax	60
☾'s Reduced Horizontal Parallax	60 16.9
☾'s Semi-diameter	16 24.1
☾'s Semi-diameter	15 36.1
Sum of Semi-diameters	32 14.5
Difference of Semi-diameters	42.0
☾'s Horary motion in Long. Prob. II.	36 41.2
☾'s Horary motion N. A.	2 25.1
☾'s Horary motion from ☉	CO 34 18.1
☾'s Horary motion in latitude	CP + 3 22.5
☾'s Latitude by Prob. I.	CG 19 37
☾'s Longitude	TV 81 41 36
☾'s Declination	DF 23 22 N.

latitude + 3' 22".5, the point P being below C because this horary motion has the sign + prefixed. Draw NGL parallel to OP. Make OP a transverse distance of 60, 60, on the line of lines of the sector, and measure from the same lines the transverse distance 35½, 35½ (corresponding nearly to the minutes in the time of new moon) this distance set on the line GN to the right of G reaches to the point *x* where the hour preceding the new moon is to be marked, viz. 23h. Take OP in the compasses and mark it successively on the line NL from *x* or 23h. to the right to 22h. and to the left to 24h. or 0h. 1h. &c. These are subdivided into five minutes, the scale not admitting smaller divisions. Take the moon's reduced horizontal parallax 60' 16".9 from the scale of equal parts, and with that radius describe about the centre C the circle ARB. Set off (by means of the sector) the arches RT, RU, each equal to 23° 28'. Join TQU and about that diameter describe the circle TYU. Make the arch TV equal to the sun's longitude 81° 44' 36", which is done by setting the radius QT as a chord from T to U, and then the arch UV = 24° 44' 36" by means of the sector. Draw P'V parallel to CR to meet TU in the point P'. Join CP' and continue it to meet the circle ARB in W. Make (by the sector) the arches WD, Wd, equal the complement of the latitude of the place 47° 26½ nearly, the radius being CB. In a similar manner make the arches DE, df, de, &c. each equal to the sun's declination 23° 22'. Draw the lines Ff, Dd, Ee, cutting CW in *l*, *q*, *n*. Bisect *ln* in *r*. Draw the line VI, *r*, XVIII parallel to Dd and make *r*, VI, *r*, XVIII, each equal to *q*D. Through the points *l*, VI, *n*, XVIII, *l*, draw the path of the spectator as taught in the above rule, and mark the hour of noon 0h. at the point *n* because the sun's declination is north. Mark the following hours in succession to the left I, II, III, &c. as in the figure. Take an extent in the compasses equal to the sum of the semi-diameters of the sun and moon 32' 14".2 and beginning towards N. find, as above directed, the points *p*'Z' at that distance apart and marked with the same time 22h. 7' nearly, which is the time of the beginning of the eclipse. Proceed in the same way for the end of the eclipse corresponding to the points *p*", Z", and to the time 0h. 5' which is the time of the end of the eclipse. Take the difference of the semi-diameters of the sun and moon 42" in the compasses, and proceed in the same way to find the beginning and end of total darkness 23h. 27m. and 23h. 31m. The points corresponding could not be drawn in the figure as they are so near to *p* and Z, and the scale small. Find by trial the points *p* Z marked with the same time and at the least distance apart, this will be the time of the middle of the eclipse 23h. 29'. With an extent equal to the moon's semi-diameter 16' 25".1 as a radius, describe about *p* the circle whose diameter is Ma



representing the moon's disc, and with the sun's semi-diameter $15' 46''.1$, describe about Z the circle whose diameter is 8 s representing the sun's disc at the middle of the eclipse. The sun's disc being wholly covered by the moon, indicates that the eclipse was total. Describe in the same way about p and Z' the discs of the sun and moon, at the beginning of the eclipse, touching each other in g . Draw CZ cutting the moon's disc in c and a . Then the arch $c g$ will be the distance of the first point of contact of the sun and moon from the sun's zenith towards the western part of the limb.

REMARKS.

1. The correction for the spheroidal form of the earth, the augmentation of the moon's semi-diameter, inflexion and irradiation, are neglected in the above rule as not sensibly affecting the result of the projection, though these points might be attended to by the following precepts.

2. From the latitude of the place subtract the correction of latitude of Tab. XXXVIII. and from the moon's horizontal parallax decreased by $8''.8$ subtract the correction of parallax in the same table, the remainders will be the corrected latitude and parallax to be made use of in the above rule to correct for the spheroidal form of the earth.

3. Decrease the moon's semi-diameter given by the N. A. by $8'$ for inflexion.

4. Decrease the sun's semi-diameter $5'$ for irradiation, and from the remainder subtract a correction equal to the augmentation (Tab. XV.) that the moon's semi-diameter would have when at the same altitude as the sun, the remainder will be the corrected semi-diameter of the sun, to be used in the above rule in finding all the times and phases of the eclipse. This method of decreasing the sun's semi-diameter produces nearly the same result as that by augmenting the moon's semi-diameter, horary motion and horizontal parallax, and taking the sun's semi-diameter as given in the Nautical Almanac.

5. Besides these corrections, there are others depending on the change of the moon's semi-diameter, horizontal parallax and horary motion during the eclipse, but all these corrections are usually neglected in projecting an eclipse or occultation.

6. The altitude of the sun, which is nearly the same as that of the moon during the eclipse, may easily be found by means of the projection. Thus if it were required at the beginning of the eclipse when the spectator is at Z . Take the distance CB and apply it as a transverse distance $90^\circ, 90'$, to the sides of the sector, then the distance CZ' applied in the same manner to those lines, will give the zenith distance of the sun, about 31° , corresponding to the altitude 59° . The correction (Table XV.) corresponding to this altitude is $14''$, which is nearly the correction to be subtracted from the sun's semi-diameter $15', 43''.6$ (corrected for irradiation) to obtain the corrected semi-diameter $15', 29''.6$, as taught in §4. Table XV. was calculated for the mean semi-diameter $15', 37''$ and the correction of the Table 14 ought to be increased in ratio of the sun's semi-diameter $15', 46''.1$ to $15', 37''$ when very great accuracy is required. The difference of the corrected semi-diameters of the sun and moon $15', 29''.6$ and $16', 26''.1$ is $57''\frac{1}{2}$, which is to be used instead of $18'$ in finding the beginning and end total phases. The duration of the total darkness found by the corrected values $57''\frac{1}{2} = 4\frac{1}{2}$ minutes, but with the uncorrected value $42'$ is only 3 minutes. It was probably owing to the neglect of this correction that some of the Almanacs published in this country, for 1806, mentioned the duration as 3 minutes.

7. The path of the spectator I, II, III, IV, &c. calculated for the proposed latitude $42^\circ 33' 30''$ may be made to answer for any other latitude by altering the centre of projection and the scale of equal parts. By this means the trouble of repeatedly describing that path, when the eclipse is to be calculated for several places may be avoided. To do this add the Prop. Log. of the reduced parallax to the log. secant of the latitude of the place, the sum, rejecting 10 in the index, will be the Prop. Log. of an arch A. To this Prop. Log. add the log. secant of the sun's declination (or star's in an occultation) and the log. co-tangent of the latitude of the place, the sum, rejecting 20 in the index, will be the Prop. Log. of the arch B. Take the radius r , VI (or qd) in the compasses, and make it a transverse distance on the line of lines of the sector corresponding to the arch A, and with that opening of the sector measure the transverse distance corresponding to the arch B which set from r towards C on the line rC (continued if necessary) will reach to the centre of the projection corresponding to the proposed latitude; the transverse distance corresponding to the reduced parallax measured from the line of lines, with the same opening, will be the radius of the projection, and the transverse distance corresponding to the horary motion of the moon from t e. in or star in an occultation, will be the horary distance to be made use of in marking the hours on the lunar orbit I.N; lastly, the latitude of the moon at the conjunction t to be measured as a transverse distance, and set from the new centre of projection on a line drawn through it parallel to CR , and the point where it reaches will be the new point t corresponding to the place of the moon at the syzygial conjunction. Through this point the line of the moon's path is to be drawn parallel to the line I.N of the figure, and the hours are to be marked

on it as before. Whence the times of beginning and end of the eclipse may be found as in the above rule. An example of this method is not given, as it would render the scheme too confused.

PROBLEM XII.

To project an occultation of a fixed star by the moon, at any given place.

The method of projecting an occultation is nearly the same as that of an eclipse of the sun, but to save the trouble of reference it was thought expedient to give the rule without abridgment.

RULE.

To the time of the ecliptic conjunction of the moon and star, given in the first page of the Nautical Almanac (or calculated by Prob. III.) add the longitude of the proposed place turned into time, if east, but subtract if west, the sum or difference will be the time of conjunction at the proposed place. Corresponding to the time of conjunction at Greenwich, find by Problem I. the moon's latitude, horizontal parallax and semi-diameter, also the sun's right ascension. Then by Problem II. find the horary motion of the moon in longitude and latitude, and by Tables VIII. and XXXVII. the star's Right Ascension, Declination, Longitude and Latitude.†

Draw the line ACB (Plate XII. fig. 3.) representing a parallel of the ecliptic passing through the star, and perpendicular thereto the line CPR. Take a scale of equal parts to measure the lines of the projection, and from it take an interval equal to the difference of the latitudes of the moon and star, and apply it to the line CR from C to G above the line ACB if the moon's latitude is north of the star's, otherwise below*. Take CO equal to the horary motion of the moon in longitude, and set it on the line CB to the right hand of C to O; take CP equal to the moon's horary motion in latitude found with its sign by Problem II. and set it on the line CR from C to P, above† the line ACB, if its sign is —, below if +. Join OP which represents the horary motion of the moon on her orbit, and parallel to that line draw the orbit of the moon NGL, on which are to be marked the places of the moon before and after the conjunction by means of the horary motion OP, so that the moment of the ecliptic conjunction at the proposed place may fall exactly at the point G, as in the figure where the conjunction is at 18h. 12'. This may be done by making OP equal to the transverse distance 60, 60, on the line of lines of the sector, then measuring from the same lines the transverse distance corresponding to the minutes and parts of a minute in the time of the ecliptic conjunction at the place of observation, and setting it on the line GN from G towards the right to the point x, the place of the moon at the first whole hour‡ preceding the conjunction (which in the present figure is 18h.) Then the distance OP being taken in the compasses, and set from x to the right hand, gives successively the preceding hours, and the same distance set to the left gives the following hours, as in the figure, where they are marked 17h. 18h. 19h. 20h. These hours are to be divided into 60 equal parts representing minutes, the scale being taken sufficiently large for that purpose.† In the present figure the subdivisions are carried only to five minutes. Take the moon's horizontal parallax from the scale of equal parts for the radius CB; with which on the centre C, describe the circle BRA cutting CR in R. Open the sector till the transverse distance 60°, 60°, on the line of chords, is equal to the radius CB, and measure from that line the transverse distance 23° 28' (equal to the obliquity of the ecliptic) which set on the circle ARB on each side of R to T and U. Join TU cutting CR in Q. On Q as a centre, with the radius QT, describe a circle TYUV, on which set off the arch TYV, equal to the star's longitude. Through V draw the line VP' parallel to CR. Open the sector till the transverse distance 90°, 90°, on the sines, is equal to the radius CB, then take in the compasses from the same lines an extent equal to the transverse distance corresponding to the complement of the declination of the star, and with one foot in C sweep a small arch to cut the line VP' in P' the place of the pole of the earth.*† Draw CP', and continue it on either side so as to cut the circle ARB in the point W situated above AB, if the latitude of the proposed place is north, but below if south. In the proposed figure the latitude is north. (If it had been south the lower part of the circle ARB ought to have been made use of.) Open the sector

† In strictness these quantities ought to be corrected for Aberration and Nutation by Tables XXXIX. — XLIII. but the correction is so small that it may always be neglected. If the Right Ascension and Declination only are given, the latitude and longitude may be found by Problem XIX. and if the latter are given, the former may be calculated by Problem XX.

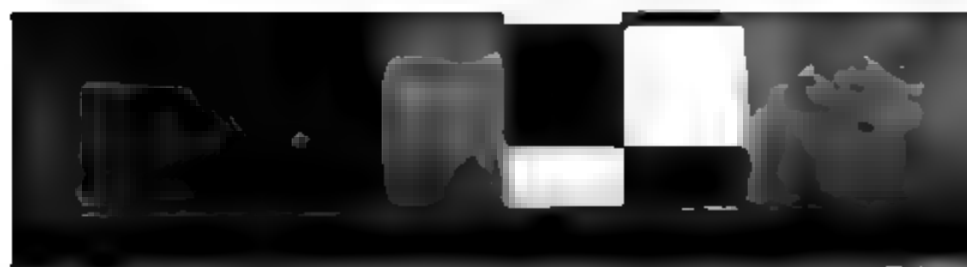
* In the figure the point G is placed above ACB, because the moon is in a less southern latitude than the star. This part of the rule may also be thus expressed. Find the moon's latitude with its sign as in Problem II. Prefix the sign + to the star's latitude if north, the sign — if south. Add the latitudes, noticing the signs as in algebra, and the distance CG will be obtained. If its sign is — the point G is to be placed above C, but below C if the sign is +.

* See note with this mark in page 592.

† See note with this mark in page 592.

‡ See note with this mark in page 594.

*† The distance of the line WV from the line CR, the situation of the point P' and the path of the spectator, may be found as in the note § page 594.



as before so as to make the transverse distance of 60° , $60'$, on the chords, equal to CB , and take the chord of the complement of the latitude of the place, which set from W on each side, to D and d . With the same opening of the sector measure the chord of the star's declination, which set on the circle AKB from the point D on each side, to E and F , and Er as d on each side to e and f . Draw the dotted lines Ff , Dd , Ee , cutting CW in l , q , n . Bisect ln in r , and erect the line lr perpendicular to CW and make rl , rn each equal to qD . Open the sector to make the transverse distance 90° , $90'$, on the sines equal to rl , and on each side of r mark on the line lr the sines of 15° , 30° , 45° , 60° , 75° , (equal to $1h$, $2h$, $3h$, $4h$, $5h$, respectively) to that radius, and mark the points with those degrees as in the figure; through these points draw the dotted lines parallel to ln as in the figure. Open the sector so that the radius rl may correspond to the transverse distance 90° , $90'$, on the sines, and measure the complements of the former degrees as transverse distances on the sines, viz. 75° , 60° , 45° , 30° , 15° , and set them on the above dotted lines, on each side of the points 15° , 30° , &c. respectively, above and below the line lr . A regular curve $nlfn$ drawn through the extremities of these dotted lines, will represent the path of the spectator in the given latitude. Subtract the sun's right ascension from the star's (increasing the latter by 24 hours when necessary) the remainder will be the hour of the star's passage the meridian,* which is to be marked at the upper point l of the path if the star's declination is south, but at the lower point n if the declination is north. The other hours are to be marked from this point towards the left, by marking successively, at the points where the dotted lines meet the path, the hour of the star's passing the meridian, increased by $1h$, $2h$, $3h$, &c. completely round the curve, observing to reject 24 hours when the sum exceeds 24h. In the present example the star's declination is south, consequently the upper point l of the path is taken for the hour of passing the meridian $14h$, $54'$. The extremities of the dotted lines to the left being marked successively $20h$, $31'$, $21h$, $34'$, $22h$, $54'$, $23h$, $44'$, $0h$, $54'$, &c. The path touches the circle AKB in two points, representing the points of rising and setting of the star, which in the present figure are $14h$, $9'$ and $1h$, $39'$. These points divide the path into two parts, of which one represents the path while the star is above the horizon, the other when below, as is evident from the hours marked on the curve. The half hours or any other intermediate time may be marked in a similar manner. Thus, for the time $4h$, $24'$, which is $7h$, $11'$ or $5h$, $49'$ from the time $7h$, $54'$, marked at the point n ; set the sine of 52° to the radius rl from r to k on the line rl , and erect the perpendicular hk , equal to the sine of $17^\circ \frac{1}{2}$ (which is the complement of $52^\circ \frac{1}{2}$) to the radius rn , and the point k will represent the place of the spectator at the proposed time. In this way the halves and quarters of hours may be marked on those parts of the path where necessary. The smaller subdivisions may generally be obtained to a sufficient degree of exactness by dividing the quarters of hours into equal parts.

Take from the scale of equal parts an extent equal to the semi-diameter of the moon, and beginning at the line Nl , towards N , find by trials the point p' of the moon's path and the point Z' of the path of the spectator, marked with the same time and at that distance apart. That time will be the beginning of the occultation or immersion at the proposed place. Proceed in the same manner towards the point l , and find the points p , Z , at the same distance apart, the corresponding time will be the end of the occultation or emersion. About the points p' , p , as centres, with a radius equal to the moon's semi-diameter, describe the small circles meeting the paths of the spectator in the points Z' , Z . These circles will represent the moon's disc; the points Z' , Z , the places of the star, and the lines CZ' , CZ , the vertical circles passing through the star at the times of immersion and emersion respectively. To render this part of the scheme more distinct to the eye, it is drawn separately in Fig. 9, Plate XII. in which the point C , p' , Z' , are similarly situated to the corresponding points of Fig. 8, marked with the same letters. Through p' draw the line $a'p'e'$ parallel to CZ' , to meet the moon's disc in a' , e' . Then the circle $d'Z'e'$ being held between the eye of the observer and the sun, the engraved or marked side of the figure towards the eye, and the line CZ (or $a'p'e'$) in a vertical position with the point Z above C , will represent the appearance of the moon and star as viewed by the naked eye, e' will represent the upper part of the moon, a' the lower part, and Z' the point of contact. The contrary will be observed if the object be viewed by an inverting telescope. It will generally be conducive to the accuracy of an observation to fixate in this manner the point of immersion, so as to keep that point of the moon's limb in the field of view of the telescope, and the eye directed towards that point of the limb, so as to perceive the star at the first instant of its appearance.—The situation of the point of emersion with respect to the horns a , b , of the moon may also be made use of for this purpose. The line apb connecting the moon's horns, is nearly parallel to the line CH , except very near the new or full moon, so that in general it will be sufficiently

* Or rather the hourly distance of the \odot and \star at the time of the celestial conjunction of the given night star.

correct to draw through p the line $p p \theta$ parallel to CR . If greater accuracy is required the following construction may be made use of. Subtract the sun's longitude from the moon's,* make the arch $TYUA$ equal to the remainder, and join UA . Set on the same circle the arch $T\beta$ equal to the moon's latitude; below the point T if that latitude is south, above if north. Through β draw the line $\beta \delta$ parallel to TQ to cut UA in δ and CR in δ . Take the extent QT and set it on the line δA above δ to μ . Join $\mu \epsilon$ and parallel thereto through p draw the line $p p \theta$ cutting the moon's disc in the points $p \theta$ representing the horns, the figure being viewed as above directed. The enlightened part of the moon is that nearest to the sun, the dark part is the most distant from it.

EXAMPLE.

Required the times of immersion and emersion of Spica, Dec. 12, 1808, at a place of the latitude of 20° N. and in the longitude of 1h. 9m. east from Greenwich?

By the first page of the Nautical Almanac for the month of December, 1808, the time of the elliptic conjunction of the moon and Spica (marked $D a$) was, December 12, 17h. 33' at Greenwich, corresponding to 19h. 42' at the proposed place. At the time at Greenwich 17h. 33' the elements of the occultation were as in the adjoined Table calculated by the above rule.

Draw ACB , and perpendicular thereto the line CGY . Make CG equal to the difference between the latitudes of the moon and star $12^\circ 20'$ taken from a scale of equal parts, the point G being above C , because the moon is northward of the star. Make CO equal to the moon's horary motion in longitude $35^\circ 55'.2$ to the right of C ; and CP equal to the horary motion in latitude $3' 2''.7$, the point P being above C because the sign is — (or the latitude is south decreasing.) Draw NGi parallel to OP . Make OP a transverse distance of 60, 60, on the line of lines of the sector, and measure from the same lines the transverse distance 12, 42 (corresponding to the minutes in the time of the conjunction) this distance set on the line GiN , from G towards the right hand, reaches to the point x of the path where the hour preceding the conjunction is to be marked, viz. 18h. Take OP in the compasses, and mark it on the line LiN from x or 18h. to the right to 17h. and to the left to 19h. 20h. &c. These are subdivided into five minutes, the scale not admitting of smaller divisions. Take the moon's parallax $59^\circ 55'.2$ from the scale of equal parts, and with that radius describe about the centre C the circle ARB . Set off (by means of the sector) the arches RP , RU , each equal to $23^\circ 28'$. Join TQU , and about that diameter describe the circle $TYUVT$. Make the arch TYV equal to the star's longitude $201^\circ 10' 31''$, which is done by making the arch $UV=21^\circ 10' 31''$. Draw PT parallel to CR , and with an extent equal to the complement of the star's declination $79^\circ 50'$, taken as a transverse distance from the sines, with the radius CB ; and with one foot in C , sweep an arch cutting PV in P' . Join CP' and continue it to meet the circle ARB in W . Set on each side of W the arches WD , Wd equal to the complement of the latitude of the place 70° . Make the arches DF , DE , $d f$ $d e$ each equal to the star's declination $10^\circ 10'$, and draw the lines $F l f$, $D q d$, $E n e$, cutting CW in l , q , n . Bisection $l n$ in r , draw trv parallel to $D q d$, and make $r t$, $r v$ equal to $q D$. Through the points l , t , n , u , v , draw the path of the spectator as taught in the above rule, and mark the hour of the star's passing the meridian 19h. 53' 50" or 19h. 54', at the upper point l , because the star's declination is south. Mark the following hours in succession 20h. 54', 21h. 54', &c. to the left, as in the figure. Take an extent in the compasses equal to the moon's semi-diameter $16' 19''.8$ and beginning towards N , find as above directed the points p' , Z' , at that distance apart, and marked with the same time 16h. 57', which is the time of the immersion. Proceed in the same way for the emersion corresponding to the points p , Z , at the same distance apart, and the time of the emersion 18h. 10' will be obtained. With the same extent describe about p and p' the small circles representing the disc

ELEMENT			
Conjunction at Greenwich	Dec. 12		17h. 33
Longitude E. from do.			1 9
Conjunction at place of observation			18 42
*'s R. ascen. Tab. VIII.			13 15 00
☉'s R. ascen. by N. A.	Sub		17 21 18
* passes the meridian			19 53 50
Latitude of the place			20° 0 0'
☉'s horizontal parallax by N. A.	CB		59 55.2
☉'s semi-diameter by N. A.			16 19.8
☉'s horary mot. in long. Prob. II.	CO		35 55.2
☉'s horary mot. in lat. Prob. II.	CP		3 02.7
*'s longitude, Tab. XXXVII.	TYV	201	10 31
☉'s latitude by N. A.		1	49 53.8
*'s lat. u. c. Tab. XXXVII.		2	2 15.8
Diff. of latitudes $D N$ of *	CG		12 30.3
*'s declination		19	10 8

* In strictness the longitude and latitude of the moon at the time of immersion or emersion ought to be made use of, but it will be sufficiently exact to use the star's longitude instead of the moon's (increasing it by 360° when less than the sun's longitude) and the moon's latitude at the conjunction. Quantities of the same order as the moon's parallax are neglected in the value of the arch $TYUA$.



TO CALCULATE THE BEGINNING OR END OF AN ECLIPSE. 601

of the moon at these times, and cutting the path of the spectator in the point Z , Z' . Join CZ' , Cp' , and parallel to CZ' , draw c' , p' cutting the moon's disc in c' , a' (as in Fig. 9, P. XII.) and the arch $a'Z$ will represent the distance of the point of immersion from the lower part a' of the moon. The line CZ runs nearly through the point p , so that the top part of the moon c and the point Z nearly coincide, consequently the emersion happened near the moon's zenith. By subtracting the sun's longitude $261^\circ 7'$ from the moon's or star's $201^\circ 10'$, (increased by 360°) the remainder is $300^\circ 3'$, which is to be marked on the circle TUV to the point λ . Make the arch $\lambda\beta$ equal to the moon's latitude $1^\circ 49' 53''$, taking the point β below T , because the latitude is south. Draw the lines $\lambda Q\beta = d$, $p\alpha$, $p\beta\theta$ as in the rule, and the points p , θ , will represent the places of the moon's horns. The point of emersion Z will be to the westward of the upper horn p , about $60'$ measured on the moon's limb.

REMARKS.

1. When it is thought necessary to take notice of the spheroidal form of the earth, the corrections of latitude and parallax of Table XXXVIII. must be subtracted from the latitude of the place and the moon's horizontal parallax respectively, to obtain the latitude and parallax to be made use of in the above rule.

2. Subtract $7'$ from the moon's semi-diameter given by the N. A. the remainder is to be made use of without augmentation, on account of the altitude of the moon.

3. The corrections for the change of the moon's semi-diameter, horizontal parallax, and horary motion during the occultation, are neglected in the above rule, as not materially affecting the result.

4. The line CZ' , measured on the sides as a transverse distance to the radius CB , will be the star's zenith distance at the immersion. In a similar manner it may be found at the emersion at Z , or at any other point.

5. The curve $ttuu$ may be made to answer for any latitude, as in Problem XI. Remark 7

Calculation of an Occultation of a Planet by the Moon.

By a similar process the times of immersion and emersion of a planet may be calculated by finding the planet's right ascension and declination, geocentric longitude and latitude from the Nautical Almanac, and using them instead of the star's. Also by Prob. II. the horary motion of the moon from the planet in longitude and latitude, which are to be used instead of the horary motion of the moon. In this projection it will not be necessary to take notice of the parallax of the planet, but it may be easily allowed for, by taking the radius CB equal to the difference of the horizontal parallaxes of the moon and planet. The apparent diameter of the planet may also be neglected, making the distances pZ , $p'Z'$ equal to the moon's semi-diameter. When great accuracy is required, the sum of the semi-diameters of the moon and planet must be made use of for finding the external contacts, and their difference for the internal contacts.

PROBLEM XIII.

To calculate the beginning or end of a solar Eclipse.

RULE.

This must be done by approximation, by assuming a time for the beginning or end of the eclipse, as for example the time obtained by projection by Problem XI. the time of new moon at the place of observation, or an hour before or after, according as it is the beginning or end of the eclipse that is sought. With this time calculate the elements of the eclipse and the parallaxes, as taught in the first part of Problem VIII. The parallaxes applied to the longitude and latitude of the moon by the N. A. will give the apparent longitude and latitude. Find the difference of the apparent longitudes of the moon and sun, and from its prop. log. increasing the index by 10. subtract the prop. log. of the moon's apparent latitude, the remainder will be the log. tangent of an angle, whose corresponding log. co-sine is to be added to the prop. log. of the diff. of longitudes, the sum, rejecting 10 in the index, will be the prop. log. of the apparent distance of the centres of the sun and moon, which ought to be equal to the sum of the corrected semi-diameters, if the assumed time was correct. If this is not the case, the operation must be repeated with an assumed time differing a few minutes from the former, and the apparent distance of the centres of the sun and moon must be calculated in this new supposition. Then add together the arith. comp. of the prop. log. of the difference of the apparent distances thus calculated, the prop. log. of the difference between the first calculated distance and the sum of the semi-diameters, and the prop. log. of the interval of time between the two suppositions, the sum, rejecting 10 in the index, will be the prop. log. of the correction to be applied to the first assumed time, which at the beginning of an eclipse is to be added to the first assumed time, if the distance be greater than the sum of the semi-diameters, but subtracted if less; and the contrary in calculating the end of an eclipse. the sum or difference will be the approximate time of the beginning or end

of the eclipse. If great accuracy is required, the operation may be repeated with this approximate time, combining this result with one of the former suppositions, and then the operation may be repeated till the apparent distance of the centres at the assumed time is found to be exactly equal to the sum of the corrected semi-diameters.

Remark. This rule, with some modification, will answer for calculating the time of an occultation of a fixed star or planet by the moon. In this case the star's longitude is to be found in Table XXXVII. and corrected for the equation Tables XL. XLI. (or the planet's longitude is to be taken from the Nautical Almanac) the difference between this and the moon's apparent longitude corresponding to the assumed time being found, its prop. log. is to be added to the log. secant of the moon's apparent latitude, and the sum is to be used in finding the distance of the centres instead of the prop. log. of the diff. long. of the sun and moon, with the index increased by 10. The latitude of the star is to be found by Tables XXXVII. and XLI. or the planet's latitude by the Nautical Almanac, and added to the latitude of the moon, if of a different name, otherwise their difference is to be taken and made use of, instead of the moon's latitude in the above rule. Lastly, instead of the sum of the semi-diameters, the semi-diameter of the moon is to be made use of. When very great accuracy is required, in calculating an occultation of a planet by the moon, the difference of the parallaxes of the moon and planet decreased by the correction of Parallax Table XXXVIII. is to be made use of as the reduced parallax, in finding the parallaxes in longitude and latitude. When the apparent distance of the centres of the moon and planet is equal to the sum of their semi-diameters, their limbs will just appear to touch each other, and when that distance is equal to the difference of the semi-diameters, the planet will be wholly covered by the moon.

EXAMPLE.

Required the time of the beginning of the solar eclipse of June, 1806, at Salem, supposing the errors of the moon's longitude and latitude in the Nautical Almanac to be unknown?

To abridge the present calculation, suppose the beginning of the eclipse to be June 15d. 22h. 6' 18".1 app. time, the elements corresponding to which have been calculated in Problem VI.; namely, \odot 's apparent longitude $84^{\circ} 8' 50''.3$, \odot 's apparent latitude, $1^{\circ} 55''.8$ N. these being corrected for the errors of the tables, $58''.5$ and $11''.4$, hence the uncorrected values are $84^{\circ} 9' 48''.8$, and $2^{\circ} 7''.2$ N. The difference between this app. long. of the moon and the sun's longitude $84^{\circ} 41' 3''.4$, is $31' 14''.6$.

Diff. long.	31' 14''.6 P. L.	10.7605	0.7505
\odot App. Lat.	2 7 .2 P. L.	1.9289	
<hr/>			
Tan.	8.8316	Corresponding co-sine	9.9370
<hr/>			
App. Dis. $\odot \odot$	31'. 19''.0	P. L.	.7536

This apparent distance differs $1' 4''.5$ from the sum of the semi-diameters $32' 23''.3$. It is therefore necessary to make a second supposition, as for example ten minutes later, or at 22h. 16' 18".1, with this time the elements are to be again calculated as in Problem VI. namely, \odot 's app. long. uncorrected $84^{\circ} 14' 7''.1$, \odot 's long. $84^{\circ} 41' 27''.2$, their difference $27' 10''.1$, \odot 's app. lat. uncorrected for error of tables $1^{\circ} 58''.8$ N.

Diff. long.	27'. 10''.1	P. L.	10.6212	0.8212
\odot App. Lat.	1 58 .8	P. L.	1.9586	
<hr/>				
Tang.		8.8628	Corresp. co-sine	9.9381
<hr/>				
[Second App. Dist. $\odot \odot$	27'. 14''.7		P. L.	.8200
<hr/>				
First App. Dist. $\odot \odot$	31. 19 0			
<hr/>				
Difference	4. 4. 3	P. L. Ar. Co.	8.3545	
Diff. ist. dist. & Semi-diam.	1. 4. 5	P. L.	2.2731	
Interval	10. 0.	P. L.	1.2655	
<hr/>				
Correction	2. 32.	P. L.	1.8556	
<hr/>				
First supposed time	15d. 22h. 6. 18.1			
Approximate time	15. 22. 3. 40.1			

If this approximate time had differed very much from the assumed times, it would be necessary to repeat the operation till the last assumed and calculated times agree.

PROBLEM XIV.

Given the moon's true longitude to find the apparent time at Greenwich.

RULE.

1. Take from the Nautical Almanac the two longitudes immediately preceding

the given longitude and the two following, and find the first and second differences as in Problem I. Call the middle term of the first differences the arch A, and the half sum of the second differences (noting the signs) the arch B.

2. To the constant logarithm 4.63549 add the arithmetical comp. log. of A in seconds, and the logarithm of the difference in seconds between the given longitude and the second longitude taken from the Nautical Almanac, the sum, rejecting 10 in the index, will be the logarithm of the approximate time T in seconds.

3. Enter Table XLV. with the arch B at the top, and this time T at the side, and find the corresponding correction to the logarithm of which add the two first logarithms above found, the sum, rejecting 10 in the index, will be the *correct sum* of the approximate time to be applied with the same sign as the arch B, and the correct apparent time, counted on from the second noon or midnight, will be obtained.

EXAMPLE.

Suppose the moon's longitude Dec. 12, 1809, was $68^{\circ} 19' 38'' 58''$. Required the apparent time? As in Example I Problem I. $A = 7^{\circ} 11' 18''$. $25878'$. $B = +4' 54''.5$ and the difference between the given longitude and the second longitude, taken from the Nautical Almanac, $68^{\circ} 17' 51' 36''$ is $1^{\circ} 47' 22''$. $-6442'$. Hence (as in the following calculation) the approximate time past midnight is $2^{\text{h}} 59' 14''$, this and the arch B gives, in Table XLV. the equation 27.3 whence the correction is $+46'$, and the sought time 3^{h} past midnight or Dec. 12d. 15h.

	Constant log	4.63549		4.63549
A	$25878'$ Ar. co. log	5.35707		6.50707
Diff long.	6442	log.	3.90902	Eq. Table XLV 27.3 Log.
				1.45213
Approx time $2^{\text{h}} 59' 14'' = 10754'$	log	4.10117	Correction $+46'$	Log.
				1.66128

PROBLEM XV.

Given the distance of the moon from a fixed star not marked in the Nautical Almanac, together with the altitudes of the objects, the apparent time of observation, and the estimated longitude, to find the longitude of the place of observation.

RULE.

To the apparent time of observation by astronomical computation, add the estimated longitude in time, if west, subtract, if east, the sum or difference will be the supposed time at Greenwich, corresponding to which find the moon's latitude by Problem L, also the longitude and latitude of the star by Table XXXII. and correct them for aberration and nutation, by Tables XI. XII.

With the apparent altitudes and distance of the objects, find the correct distance by the usual rules of working a lunar observation.

To the correct distance add the altitudes of the moon and star, and find the difference between the half sum and the distance. Then to the log secants of the latitudes of the moon and star rejecting 10 in each index, add the log secants of the half sum and difference if the latitudes are of the *same name*, or the log *cosecants* if of a *contrary name*, half the sum of these four logarithms will be the log cosecant of each the difference of longitude if the latitudes are of the *same name*, or its *complement* if of a *different name*.

The difference of longitude is to be added to the *supposed longitude* of the star if the moon is east of the star, otherwise subtracted (borrowing or rejecting 360° when necessary) the sum or difference will be the true longitude of the moon, whence the time at Greenwich may be found by Problem XIV. The difference between this and the apparent time at the ship will be the longitude which will be west if the apparent time at Greenwich be greater than the time at the ship, otherwise east.

REMARK.

This method, with a slight modification, will answer for finding the longitude from the observed distance of the moon from a planet, as Jupiter, Venus, Mars or Saturn. The only difference consists in finding from the Nautical Almanac by Problem I. the geocentric long. and lat. of the planet, which are to be used instead of the longitude and latitude of the star in the above rule. For the daily variation of the longitude and latitude of a planet is so small that an error of moment can arise from calculating those quantities for the *supposed* instead of the *true time* at Greenwich, and the peculiar and semidiameter of the planet are so small as not to affect the calculation materially.

The latitudes of the moon and the fixed star or planet made use of in these observations, ought not to differ very much, on account of the decrease of the relative motion arising from this source. If the latitudes are of a different name, their sum, otherwise their difference ought to be found, and if it does not exceed one third part of the difference of longitude of the two objects, they may in general be made use of.

EXAMPLE.

Suppose that on the 7th. January, 1808, sea account, at 6h. 57m. P. M. in the longitude of 120° W. by account, the observed distance of the farthest limb of the moon from the star Aldebaran was $39^{\circ} 7' 4''$, the observed altitude of the star $43^{\circ} 18'$, and the observed altitude of the moon's lower limb $52^{\circ} 52'$. Required the true longitude, without using the distances marked in the Nautical Almanac, upon the supposition that they were not given in it?

In this case the supposed time at Greenwich was Jan. 6d. 14h. 37m. D's horiz. par. $54' 35''$, D's S. D. $15' 5''$. Apparent distance of centres D \ast $38^{\circ} 51' 39''$, whence (by the rule page 167) the correct distance is $38^{\circ} 47' 26''$. The Moon's latitude deduced from the Nautical Almanac by Problem I. is $2^{\circ} 37' 36''$ N. The Star's longitude and latitude is found by Tables XXXVII. XL. XLI. making use of the longitude of the Moon's node 7s. $28^{\circ} 15'$, and the Sun's longitude 9s. $15^{\circ} 42'$, as given in the Nautical Almanac.

Table XXXVII. \ast Long. Jan. 6, 1808, $67^{\circ} 6' 51' 5''$ \ast Latitude $5^{\circ} 28' 49' 5''$ S.
Table XLI. \ast Aberration $+ 15' 7''$ Aberration $+ 1' 2''$

Table XL. Equat. Equinox $+ 15' 2''$ \ast App. Lat. $5^{\circ} 28' 51' 5''$ S.

\ast Apparent longitude

67 6. 52

Correct Distance

38.47. 26

D Latitude

2.37. 36 N. Sec. 0.00046

\ast Latitude

5.28. 51 S. Sec. 0.00159

Sum 46.53. 53

Half sum 23.26. 58 Sine^a 9.59961
Diff. $\frac{1}{2}$ sum and dist. 16 20. 30 Sine^a 9.42255

19.02481

$\frac{1}{2}$ Diff. of Long.

18.59. 21

Sine^a 9.51240

Diff. of Long.

37.58. 42

D West of \ast

\ast 's Longitude

67. 6. 52

D Longitude

23. 8. 10

D Long. Jan. 6d. 12h.

27.49. 6

Difference

1.19. 4=4744"

Diff.

D Longitude, Jan.

Ed. Oh.

21. 53. 10

5.55.56

2 Diff.

6. 12

27. 49. 6

A 5.57.26

+ 10.30'

7. 0

33. 46. 32

5.59.34

+ 2 8

7. 12

39. 46. 6

Mean B.

+ 1. 43

Constant log.

4.63548

4.63548

A = $59.57'.26'' = 21446''$ log. co.

5.66865

5.66865

1. 19. 4 = 4744" log.

3.67614

Eq. Tab. XLV. + 9'.4 Log.

0.97313

Approx. time 2h. 33' 16" = 9556" Log. 3.98027

Correction + 19" Log.

1.27725

Correction + 19

Time T 2. 39. 35

Hence time at Greenwich

14h. 39' 35"

App. time at ship

6. 37. 0

Longitude

2 2 3 = $120^{\circ} 53' 4''$ W.

PROBLEM XVI.

Given the intervals of time between the passages of the moon's limb and fixed star over two different meridians, to find the difference of longitude of the two meridians.

In making these observations it is usual to note the times of transit by a clock regulated to sidereal time, being the most convenient for calculation. If the intervals are given in mean solar time, they may be reduced to sidereal, by adding a proportional part of the daily difference $3' 56''.6$. Thus if the interval was 6 hours mean time, the correction would be found by saying as 24h. : 6h. :: $3' 56''.6$: $59''.1$, which added to 6h. gives the interval in sidereal time 6h. $0' 59''.1$. In the following rule it is supposed that the intervals are given in sidereal time. The constant logarithm 4.63667 made use of in the rule, is the logarithm of 43318 seconds, the number of seconds sidereal time in half a mean solar day. In strictness this quantity ought to be equal to the logarithm of the number of seconds sidereal time in 12 hours apparent time, which may differ 15 seconds from 43318" on account of the daily variation of the equation of time. The correction arising from this source is very small, and may in general be neglected, though it can be allowed for in a very simple manner, since the logarithm varies an unit in the fifth decimal place for 1" of time. Hence the correction of the logarithm is equal to half the daily variation of the equation of time is

^a Use cosine if the latitudes are of the same name.

seconds, given in the Nautical Almanac, to be added to 4.63667 when the equation of time is marked *add* and is increasing, or *sub.* and decreasing, otherwise subtracted. Thus if the observation was made July 4, 1808, the equation of time is marked *add*, and is increasing daily 19' 5" half of which or 5 is the correction to be added to 4.63667 to obtain the logarithm 4.63672, to be made use of July 4, 1808.

RULE.

If the moon be observed at both places on the same side of the star, take the difference of the observed intervals, otherwise the sum, which reduce to seconds of sidereal time, and find the corresponding logarithm, to which add the arith. comp. log. of the variation of the moon's right ascension* in 12 hours in seconds, and the log. 4.63667 (corrected for the variation of the equation of time, as directed above, when very great accuracy is necessary). The sum, rejecting 10 in the index, will be the log. of a number of seconds, from which subtract the above difference of intervals, the remainder will be the longitude in time.

The western place of observation corresponds to the greater interval if the star is west of the moon, the less if east. If the moon be observed on opposite sides of the star, the western place will be where the star is to the westward of the moon.

EXAMPLE.

Suppose that on the 4th. of July, 1808, the interval in sidereal time between the transit of the moon's western limb and Antares, observed at Greenwich, was 22' 6", and the interval at a second place was 20' 3", the increase of the moon's right ascension in 12 hours (corresponding to the middle time of the moon's transit by the meridians of the two places reduced to Greenwich time, 9h 26') being by Prob. II. Ex. III. 30' 22". The star being to the eastward of the moon. Required the longitude of the second place of observation?

Interval at Greenwich	22. 6'	Sid. time		
... at second place	20. 3			
Diff. of intervals	2. 3 = 138"		log	2.04391
Var. of R. A. in 12h. 30' 22".	1. in time = 1822"		log co.	0.73443
Constant log.	Corrected as above			4.63672
			log	2.41406
Subtract diff. intervals	222			
Remains long. in time	123			
	20' 2 = 40. 42 W from Greenwich			

This method of determining the longitude admits of a very great degree of accuracy on account of the frequent opportunities of observation. Other methods of finding the longitude depending on the same principles have been proposed. One consists in observing the apparent time of the moon's passing the meridian, and comparing it with the time of passing observed at Greenwich, or deduced from the Nautical Almanac, and taking the difference of these times, and saying, as the daily difference of the moon's passing the meridian (deduced from the Nautical Almanac for the time of observation) is to 360°, so is the above difference to the longitude of the place. Another method consists in deducing the longitude from the change of declination of the moon, obtained from her observed altitude when on the meridian, and the known latitude of the place of observation, by a method somewhat similar to the preceding, but neither of these methods is susceptible of the same degree of accuracy as that in the above Problem.

It is not absolutely necessary that the same star should be made use of at both places. For if two stars be observed, whose difference of right ascension is accurately known, that difference will be equal to the interval of passing of the two stars to the meridian in the sidereal time, and by applying this to one of the intervals, the observations may be reduced to be the same as if one star only had been used.

PROBLEM XVII.

Given the longitude of the sun and moon, and the moon's latitude, to find their distance.

RULE.—Find the difference of the two longitudes, and to its log. co-sine add the log. co-sine of the moon's latitude, the sum, rejecting 10 in the index, will be the log. co-sine of the sought distance, of the same affection as the difference of longitude.

EXAMPLE.

July 16, 1808, at noon at Greenwich, by the Nautical Almanac, the sun's longitude was 3s. 23° 40' 24", the moon's longitude 1s. 3° 14' 1", and her latitude 1° 24' 28" N. Required their distance?

* In general it will be exact enough to take the difference between the numbers of R. A. marked in the Nautical Almanac for the nearest moon and star, but when very great accuracy is required, it must be found as in Prob. II. Ex. III. for the middle time between the two transits of the moon by the meridians of the two places, reduced to Greenwich time by adding the longitude if west or subtracting if east. If a high accuracy is required, it would be proper to notice the variation of the moon's semi-diameter and declination between the observations, also to compute the effect of the variations of the proper motion, not only of the higher order of differences, but these circumstances would affect the result but very little.

† Two arcs or angles are said to be of the same affection when they are both greater or both less than 90°, but of different affection when the one is greater and the other less than 90°.

☉ Longitude	115° 40' 24"
☽ Longitude	33 14 1
Diff. long.	80 26 23
☽ Latitude	1 24 23
	co-sine 9.22033
	co-sine 9.99987
Distance	80 26 33
	co-sine 9.22020

The same as in the Nautical Almanac. The distances being calculated from noon and midnight by this (or the following) Problem, they may be interpolated for every 3 hours by Problem I. An example will sufficiently illustrate this.

EXAMPLE.

Given the distances of the sun and moon in July, 1808, at 15d. 12h. 16d. 0h. 16d. 12h. and 17d. 0h.; respectively 85° 52' 13" | 80° 26' 33" | 75° 0' 44" | and 69° 34' 9". Required the distances July 16d. at 3h. 6h. and 9h.?

1808, July	Dist. ☉ ☽	1st diff.	2d. diff.	
15d. midnight	85° 52' 13"	0		
16 noon	80. 26. 33	-5. 25. 40	-9	
16 midnight	75. 0. 44	A=-5. 25. 49	-46	
17 noon	69. 34. 09	-5. 26. 35	B=-27½	
	At 3h.		At 6h.	At 9h.
Second longitude	+ 80. 26. 33	+ 80. 26. 33	+ 80. 26. 33	+ 80. 26. 33
Prop. part ½ A	- 1. 21. 27.2	½ A - 2. 42. 54.5	½ A - 2. 42. 54.5	½ A - 2. 42. 54.5
Table XLV. T 3h.	+ 2.6	T=6h. + 3.4	T=9h. + 3.4	T=9h. + 3.4
Distance at 3h.	79. 5. 8	Distance at 6h.	77. 43. 42	Distance at 9h.
				76. 22. 4

These distances agree with the Nautical Almanac.

PROBLEM XVIII.

Given the longitudes and latitudes of the moon and a star, to find their distance.

RULE.

To the log. secant of the difference of longitude of the moon and star, rejecting 10 in the index, add the log. tangent of the greater latitude, the sum will be the log. tangent of the arch A, of the same affection as the difference of longitude. Take the sum of the arch A, and the less latitude, if the latitudes are of a *different* name, but their *difference* if of the *same* name, and call it the arch B. Then add together the log. secant of the difference of longitude, the log. secant of the greater latitude, the log. co-sine of the arch A, and the log. secant of the arch B, the sum, rejecting 30 in the index, will be the log. secant of the distance of the moon and star of the same affection as B.

EXAMPLE.

Required the distance of the moon and the star α Pegasi at noon at Greenwich, July 16, 1808, when by the Nautical Almanac the moon's longitude was 33° 14' 1", latitude 1° 24' 28" N. and by the explanation of Tables XI. XLI. the longitude of the star corrected for aberration and equation of equinoxes was 350° 49' 36", and its latitude corrected for aberration 19° 24' 41" N.?

☽'s long.	33° 14' 1"
* long.	350 49 36
Diff. long.	42 24 25
Greater lat.	19 24 41 N.
Arch A	25 30 45
Lesser lat.	1 24 28 N.
Arch B	24 6 17
Distance ☽ *	45° 13' 25"
	secant 0.13173 10.13173
	tang. 9.54701 secant 10.02542
	tang. 9.57674 co-sine 9.95544
	secant . 10.03962
	secant 10.15221

It may be observed that the log. secant of the distance is also equal to the sum of the log. co-secant of the greater latitude, the log. sine of arch A, and the log. secant of the arch B, rejecting 20 in the sum of the indices; but the above rule is in general the most convenient on account of the smallness of the greater latitude, except when the difference of longitude is nearly equal to 90°.

PROBLEM XIX.

Given the right ascension and declination of a celestial object, with the mean obliquity of the ecliptic E, to find its longitude and latitude.

RULE.

To the log. tangent of the declination add the log. co-secant of the right ascension of the object, the sum, rejecting 10 in the index, will be the log. tangent of the arch A, to be taken out less than 90°, and called *north* or *south* as the declination is. If the right ascension is less than 180°, call the obliquity of the ecliptic *south*, if above 180°, *north*. If A and E are of the same name, take their sum, otherwise their difference, which call B, and mark it with the same name as the greater number, whether N. or S. Then add together the log. secant of A, the log. co-sine of B, and the log. tangent of the right ascension, the sum, rejecting 20 in the index, will be the log. tangent of the longitude in the same quadrant as the right ascension, unless B be greater than 90°, in which case the quantity found in the same quadrant as the right ascension, subtracted from 360°, will be the longitude.

TO CALCULATE THE LATITUDE AND LONGITUDE OF A STAR. 617

To the log. sine of the longitude add the log. tangent of B, the sum, rejecting 10 in the index, will be the log. tangent of the latitude of the same name as B.

Remark. As the Tables of this collection are not marked above 180° , you must subtract 180° from the right ascension when it exceeds that quantity, and find the log. tangent and log. co-secant of the remainder, and then the arch, corresponding to the log. tangent of the longitude, is to be taken of the same affection as this remainder, and 180° , added thereto, the sum will be the longitude, unless B is greater than 90° , in which case the supplement of that sum to 360° is to be taken as observed above.

EXAMPLE.

By Table VIII the right ascension of α Pegasi, July 16, 1804, was $22^h. 55^m. 14^s. = 343^\circ. 49'. 30''$, and its declination $11^\circ. 11' N$ the mean obliquity of the ecliptic $23^\circ. 27'. 47''$. Required its longitude and latitude.

Decln.	$11^\circ. 11' 0''$	tang.	44024		
R. A.	$343^\circ. 49' 20''$	co-sec.	10.3497	tang.	246205
A	$42^\circ. 11' 12'' N.$	long.	94520	sec.	10.13020
E	$23^\circ. 27' 47'' N.$				
B	$65^\circ. 31' 59'' N.$	co-sine	361577	tang.	10.34131
	Longitude $330^\circ. 49' 19''$	tang.	920757	sine	0.20277
		Lat $10^\circ. 24' 54'' N$	tang.	324703	

PROBLEM XX

The longitude and latitude of a celestial object being given with the mean obliquity of the ecliptic E, to find the right ascension and declination.

RULE.

To the log. tangent of the latitude add the log. co-secant of the longitude, the sum, rejecting 10 in the index, will be the log. tangent of the arch A, which is to be called north or south as the latitude is. If the longitude is less than 180° , call the obliquity E north, if above 180° , south. If A and E are of the same name, take their sum, otherwise their difference, which call B marking it with the same name as the greater number. Then add together the log. secant of A, the log. co-sine of B, and the log. tangent of the longitude, the sum, rejecting 20 in the index, will be the log. tangent of the right ascension in the same quadrant as the longitude, unless B be greater than 90° , in which case the quantity found in the same quadrant as the longitude, subtracted from 360° , will be the right ascension.

To the log. sine of the right ascension add the log. tangent of B, the sum, rejecting 10 in the index, will be the log. tangent of the declination of the same name as B.

Remark. If the longitude exceeds 180° you must subtract 180° from it, and find the log. tangent and log. co-secant of the remainder. The arch corresponding to the log. tangent of the right ascension is to be taken of the same affection as this remainder, and 180° added thereto will be the right ascension, unless B is greater than 90° , in which case the supplement of that sum to 360° is to be taken as was observed above.

EXAMPLE.

By Table XXXVII. the mean longitude of α Pegasi, July 16, 1806, was $350^\circ. 49'. 11''$, its latitude $19^\circ. 24'. 17'' N$. and the mean obliquity of the ecliptic $23^\circ. 27'. 47''$. Required its right ascension and declination?

Lat.	$19^\circ. 24' 17'' N$	tang.	834705		
Long.	$350^\circ. 49' 11''$	co-sec.	10.7712	tang.	0.20247
A	$65^\circ. 30' 51'' N.$	long.	945117	sec.	10.33465
E	$23^\circ. 27' 47'' N.$				
B	$42^\circ. 10' 47'' N.$	co-sec.	10.2371	tang.	720718
	Right ascension $322^\circ. 4'. 22''$	long.	940257	sine	0.44359
		Declination $14^\circ. 10' 10'' N$	tang.	44027	

If the given longitude, latitude, and obliquity are the mean values, the resulting right ascension and declination will be the mean values, but if the proposed quantities are corrected for aberration and nutation, the resulting quantities will also be corrected. This remark is equally applicable to the preceding Problem.

SPHERIC TRIGONOMETRY.

Most of the rules given in the preceding Problems may be easily demonstrated by Spheric Trigonometry. As for example that of Problem XVII may be investigated as follows. In Plate XII, Fig. 1, let A be the place of the moon C that of the sun, CP an arch of the ecliptic, and AP a circle of latitude passing through the moon and cutting the ecliptic at right angles at P. Then the difference of longitude of the sun and moon is equal to the arch CP, and the moon's latitude is AP, whence the distance AC may be found by the rule of Napier radius \times co-s. AC = co-s. AP \times co-s. CP. This in logarithms gives log. co-s. AC = log. co-s. AP + log. co-s. CP - log. radius, which is the formula made use of. Hence if mean quantities be substituted for the instantaneous

The celebrated rules given by Lord Napier for solving the problems of Right-Angled Spheric Trigonometry being very easily remembered, are much made use of by mathematicians. In a paper communicated by the author of this work to the American Academy of Arts and Sciences, and published in the third volume of the memoirs of that society, a method was given for the more easy application of those rules to oblique Spheric Trigonometry, and as the tables of this collection may sometimes be made use of in solving various problems of Spherics besides those given in the former part of this work, it was thought proper to insert this improved method, with the formulas most frequently made use of, to enable any person acquainted with Spheric Trigonometry to make use of the tables, without the trouble of referring to another work, for the rules.

In every Right-angled Spheric triangle there are *five circular parts*; namely, the two legs, the complement of the hypotenuse, and the complements of the two oblique angles, which are named *adjacent* or *opposite*, according to their positions, with respect to each other. The right-angle is not included as one of the circular parts, neither is it supposed to separate the legs. In all cases of right-angled Spheric Trigonometry, two of these parts are given to find the third. If the three parts join, that which is in the middle is called the middle part; if they do not join, two of them must, and the other part which is separate, is called the middle part, and the other two opposite parts, as in Plate XII. fig. 1, 2. Then putting the radius equal to unity, the equations given by Napier will become

$$\begin{aligned}\text{Sine of middle part} &= \text{Rectangle of the tangents of the adjacent parts.} \\ &= \text{Rectangle of the co-sines of the opposite parts.}\end{aligned}$$

The method of applying these solutions to the various cases of Right-angled Spheric Trigonometry is very simple, and is explained in several treatises. To apply the method to Oblique-angled Spheric Trigonometry, it is necessary to divide the triangle into two right-angled spheric triangles by means of a perpendicular AP (Plate XII. fig. 3, 4, 5, 14.) let fall from the point A upon the opposite side BC: the perpendicular being so chosen as to make two of the given things fall in one of the right-angled triangles, or in other words the perpendicular ought to be let fall from the end of a given side and opposite to a given angle.* Each triangle thus found, contains, as above, five circular parts, the perpendicular being counted and bearing the same name in each of them: consequently the parts of each triangle similarly situated with respect to the perpendicular, must have the same name. In every case of Oblique-angled Spheric Trigonometry, there are three parts given to find a fourth, and in making use of the method of a solution by means of the perpendicular, there will in general be two of these parts in each of the triangles ACP, ABP, similarly situated with respect to each other. To each of these must be joined the perpendicular AP, and there will be three parts in each triangle, which are to be named *middle*, *adjacent* or *opposite*, according to the above directions. Then the equations for solving all the cases of Right-angled, and all except two cases of Oblique-angled Spheric Trigonometry are,

$$1. \text{ Sine middle part } \begin{cases} = \\ \propto \end{cases} \begin{cases} \text{Tangents of the adjacent parts.} \\ \text{Co-sines of the opposite parts.} \end{cases}$$

These equations, when applied to right-angled spheric triangles, signify as before, that the sine of the middle part is equal to the rectangle of the tangents of the adjacent parts, or to the rectangle of the co-sines of the opposite parts; but when applied to an oblique-angled triangle, they signify, that the sines of the middle parts are proportional to the tangents of the adjacent parts: or that the sines of the middle parts are proportional to the co-sines of the opposite parts of the same triangle; observing that the perpendicular being common to both triangles APB, APC, and bearing the same name in each of them, must not be made use of in the analogies, nor counted as a middle part. This can produce no embarrassment, because the cases of Oblique Spheric Trigonometry may in general be solved in the shortest manner without calculating the perpendicular.

The first case not included in the above rules, is where the question is between two sides and the opposite angles, which may be solved by the noted theorem, that the sines of the sides are proportional to the sines of the opposite angles, or as it may be expressed in an abridged form or more easy reference.

$$2. \text{ Sine side } \propto \text{ sine opp. angle.}$$

This, combined with the above improved formula, furnish a complete solution of the various cases of Spheric Trigonometry, except where three sides are given to find an angle, or (which is nearly the same thing, by taking the supplementary triangle) three angles to find a side. The above rules marked (1,) (2,) are simple in their

* When this can be done in two different ways (as in cases II. IV.) it will generally produce the shortest solution to make use of that perpendicular which does not divide the required angle or side into segments.

† It will be of considerable assistance in remembering these rules to note that the second letters of the words *tangent* and *co-sine* are the same as the first letters of *adjacent* and *opposite*.

form, and the first varies but little from that made use of by Napier, so that it is extremely easy to remember them. The case not included in these rules may be solved by one of the formulas of case V. or VI which may be committed to memory with little trouble. To illustrate these rules, the following examples are given, which include all the cases of Oblique Spheric Trigonometry.

CASE I. PLATE XII. Fig. 1, 4, 5, 14.

Given AB , AC , and the opposite angle C , to find BC and the angles A , B .

In the right-angled spheric triangle APC are given AC and C , and by marking it as in Fig. 2, CP may be found by the rules *sine mid. = tang. adj.*, which gives $\text{sine } (co. C) = \text{tang. } CP \times \text{tang. } (co. AC)$, or $\text{tang. } CP = co-s. C \times \text{tang. } AC$. Then in the triangles ABP , ACP are given AB , AC and CP to find BP . If to these is joined the perpendicular AP it will be found that in the triangle ACP the complement of AC is the middle part (as in Fig. 3), and CP an opposite part. The triangle ABP is to be marked in a similar manner. Then the rule *sine mid. \propto co-s. opp.* gives $\text{sine } (co. AC) = co-s. CP \times \text{sine } (co. AB) = co-s. BP$, and $BC = BP + CP$. By marking the segments as in Fig. 4,

the rule *sine mid. \propto tang. adj.* gives $\text{sine } CP \times \text{tang. } (co. C) = \text{sine } BP \times \text{tang. } (co. B)$. Having found BC , the angle A may be found by the rule *sine side \propto sine opp. angle* which gives $\text{sine } AB \times \text{sine } C = \text{sine } BC \times \text{sine } A$.

Otherwise—If the side BC is not required, the angles A , B , may be found in the following manner. The rule *sine mid. = tang. adj.* gives by marking as in Fig. 1 $\text{sine } (co. AC) = \text{tang. } (co. C) \times \text{tang. } (co. CAP)$ or $\cot CAP = co-s. AC \times \text{tang. } C$, and by marking as in Fig. 5, the rule *(sine mid. \propto tang. adj. (1) tang. adj. (2) sine mid)* gives $\text{tang. } (co. AC) = \text{sine } (co. CAP) \times \text{tang. } (co. AB) = \text{sine } (co. BAP)$, then $A = BAP + CAP$. By marking the segments as in Fig. 11, the rule *(sine mid. \propto co-s. opp. or) co-s. opp. \propto sine mid.* gives $co-s. (co. CAP) = \text{sine } (co. C) = co-s. (co. BAP) = \text{sine } (co. B)$ or $\text{sine } CAP = co-s. C = \text{sine } BAP = co-s. B$. Having A , C , and AB , BC may be found by the rule *sine side \propto sine opp. angle*, which gives $\text{sine } C = \text{sine } AB \times \text{sine } A = \text{sine } BC$.

CASE II. Fig. 3, 4. Plate XII.

Given AC , BC and the included angle C to find AB , and the angles A , B .

The rule *sine mid. = tang. adj.* gives as in Case I $\text{tang. } CP = co-s. C \times \text{tang. } AC$, then $BP = BC + CP$ and the rule *co-s. opp. \propto sine mid.* gives by marking, as in Fig. 2 $co-s. CP = \text{sine } (co. AC) = co-s. BP = \text{sine } (co. AB)$ and by marking as in Fig. 1, the rule *sine mid. \propto tang. adj.* gives $\text{sine } CP = \text{tang. } (co. C) = \text{sine } BP \times \text{tang. } (co. B)$. Having found AB we may find A , by the rule *sine side \propto sine opp. angle*, which gives $\text{sine } AB \times \text{sine } C = \text{sine } BC \times \text{sine } A$.

If the angle A had been required and not B , it would have been shorter to let the perpendicular fall upon the point B , by which means the required angle A would not be divided into segments. In this case the side AB and the angle A might be found in a similar manner to that by which AB and B are found above.

CASE III. Fig. 3, 4, 5, 14. Plate XII.

Given the angles B , C , and the opposite side AC to find BC , AB , and the angle A .

The rule *sine mid. \propto tang. adj.* gives as in Case I $\text{tang. } CP = co-s. C \times \text{tang. } AC$. Then the rule *tang. adj. \propto sine mid.* gives, by marking as in Fig. 1 $\text{tang. } (co. C) = \text{sine } CP = \text{tang. } (co. B) = \text{sine } BP$, then $BC = CP + BP$. Again the rule *co-s. opp. \propto sine mid.* gives by marking as in Fig. 3, $co-s. CP = \text{sine } (co. AC) = co-s. BP = \text{sine } (co. AB)$. Having found BC , the rule *sine side \propto sine opp. angle*, gives $\text{sine } AC = \text{sine } B \times \text{sine } BC = \text{sine } A$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

Otherwise—The rule *sine mid. = tang. adj.* gives as in Case I $\cot CAP = co-s. AC \times \text{tang. } C$, and the rule *sine mid. \propto co-s. opp.* gives by marking as in Fig. 11, $\text{sine } (co. C) = co-s. (co. CAP) = \text{sine } (co. B) = co-s. (co. BAP)$, or $\text{sine } C = \text{sine } CAP = co-s. B = \text{sine } BAP$, and $A = CAP + BAP$. Then the rule *sine side \propto sine opp. angle* gives by

marking as in Fig. 5, $\text{sine } (co. CAP) = \text{tang. } (co. AC) = \text{sine } (co. BAP) \times \text{tang. } (co. AB)$. Having found A the rule, *sine side \propto sine opp. angle* gives $\text{sine } B = \text{sine } AC = \text{sine } A \times \text{sine } BC$.

CASE IV. Fig. 5, 14. Plate XII.

Given the angles A , C and the included side AC , to find AB , BC and the angle B .

The rule *sine mid. = tang. adj.* gives as in Case I. $\cot. CAP = \text{co-s. } AC \tan. C$, and $BAP = A + CAP$. The rule *sine mid. \propto tang. adj.* gives by marking as in

Fig. 5, $\text{sine (co. CAP)} : \text{tang. (co. AC)} :: \text{sine (co. BAP)} : \text{tang. co. (AB)}$. The rule *cos. opp. \propto sine mid.* gives by marking as in Fig. 14, $\text{co-s. (co. CAP)} : \text{sine (co. C)} :: \text{co-s. (co. BAP)} : \text{sine (co. B)}$ or $\text{sine CAP} : \text{co-s. C} :: \text{sine BAP} : \text{co-s. B}$. Having found B , the rule *sine side \propto sine opp. angle* gives $\text{sine B} : \text{sine AC} :: \text{sine A} : \text{side BC}$.

If the side BC had been required and not AB , it would be shorter to let the perpendicular fall from the point C , by which means the required side BC would not be divided into segments. In this case the side BC and the angle B might be found in a similar manner to that by which AB and B are found above.

CASE V. Fig. 3.

Given AB , AC , and BC , to find either of the angles a or A .

Put $S = \frac{1}{2} (AB + AC + BC)$, then the angle A may be found by either of the following theorems, in which for brevity the words *sine*, *co-sine*, &c. are used for *log. sine*, *log. co-sine*, &c.

$$(3) \text{Sine } \frac{1}{2} A = \frac{\text{Sine } (S - AB) + \text{sine } (S - AC) + \text{co-sec. } AB + \text{co-sec. } AC - 20}{2}$$

$$(4) \text{Co-s. } \frac{1}{2} A = \frac{\text{Sine } S + \text{sine } (S - BC) + \text{co-sec. } AB + \text{co-sec. } AC - 20}{2}$$

CASE VI. Fig. 3.

Given the angles A , B , C , to find either of the sides as BC .

Put $S = \frac{1}{2} (A + B + C)$. Then the side BC may be found by either of the following theorems, adapted to logarithms as in the last example.

$$(5) \text{Sine } \frac{1}{2} BC = \frac{\text{Co-sine } S + \text{co-sine } (S - A) + \text{co-sec. } B + \text{co-sec. } C - 20}{2}$$

$$(6) \text{Co-sine } \frac{1}{2} BC = \frac{\text{Co-sine } (S - B) + \text{co-sine } (S - C) + \text{co-sec. } B + \text{co-sec. } C - 20}{2}$$

The above includes all the cases of Oblique Trigonometry. The 2d. and 4th. case may be solved in a different manner by the following theorems, which on some occasions may be found very useful. Thus both the angles in Case II. may be found by the following theorems.

$$(7) \text{Sine } \frac{1}{2} (AC + BC) : \text{sine } \frac{1}{2} (BC - AC) :: \cot. \frac{1}{2} C : \text{tang. } \frac{1}{2} (A - B).$$

$$(8) \text{Co-sine } \frac{1}{2} (AC + BC) : \text{co-sine } \frac{1}{2} (BC - AC) :: \cot. \frac{1}{2} C : \text{tang. } \frac{1}{2} (A + B).$$

$\frac{1}{2} (A - B)$ is less than 90° and $\frac{1}{2} (A + B)$ is of the same affection as $\frac{1}{2} (AC - BC)$.

The sum and difference of the terms $\frac{1}{2} (A - B)$ and $\frac{1}{2} (A + B)$ will give A and B .

Both the sides in Case IV. may be found thus:

$$(9) \text{Sine } \frac{1}{2} (A + C) : \text{sine } \frac{1}{2} (A - C) :: \text{tang. } \frac{1}{2} AC : \text{tang. } \frac{1}{2} (BC - AB).$$

$$(10) \text{Co-sine } \frac{1}{2} (A + C) : \text{co-sine } \frac{1}{2} (A - C) :: \text{tang. } \frac{1}{2} AC : \text{tang. } \frac{1}{2} (BC + AB) \quad \frac{1}{2} (BC - AB) \text{ is less than } 90^\circ, \text{ and } \frac{1}{2} (BC + AB) \text{ is of the same affection as } \frac{1}{2} (A + C).$$

Then the sum and difference of $\frac{1}{2} (BC - AB)$ and $\frac{1}{2} (BC + AB)$ give AB and BC .

The improved rule for solving the cases of Oblique Spheric Trigonometry by the circular parts, may be easily deduced from those given by Lord Napier. For if we put M for the middle part, A for the adjacent part, and B for the opposite part of the triangle APC (Fig. 3, 4, 5, 14, Plate XII.) m , a , b , for the corresponding parts of the triangle APB ; and P for the perpendicular AP . Then if P is an adjacent part, the rules of

Napier will give $\text{tang. } P = \frac{\text{sine } M}{\text{tang. } A}$ and $\text{tang. } P = \frac{\text{sine } m}{\text{tan. } a}$ hence $\frac{\text{sine } M}{\text{tang. } A} = \frac{\text{sine } m}{\text{tan. } a}$ consequently $\text{sine } M : \text{tang. } A :: \text{sine } m : \text{tang. } a$. If P is an opposite part, the same rule

will give $\text{co-s. } P = \frac{\text{sine } M}{\text{co-s. } B}$ and $\text{co-s. } P = \frac{\text{sine } m}{\text{co-s. } b}$ hence $\frac{\text{sine } M}{\text{co-s. } B} = \frac{\text{sine } m}{\text{co-s. } b}$ consequently $\text{sine } M : \text{co-s. } B :: \text{sine } m : \text{co-s. } b$, which are the two rules to be demonstrated.

APPENDIX TO THE SIXTH EDITION.

ON FINDING THE LATITUDE BY TWO ALTITUDES.

SINCE the part of this work for the finding the Latitude by two altitudes was in the press, the following Table XLVIII. has been computed, by means of which the correction of either one of the observed altitudes can be computed for the change of declination of the observed object during the elapsed time between the observations, and thus the Problems of double altitudes of the sun, moon, planet, or fixed star, can be reduced to the case of the declination, being invariably the same as at the time of the observation of the altitudes which is not corrected, and then the Problem comes under the first (or second) method of solution, which is much more simple and free from cases than the general solution by the *third* method. This process of correcting the altitude is somewhat similar to that before taught, for making allowance for the run of a ship during the time elapsed between the observations, and the same altitude, which is corrected for the run of the ship, can also be corrected for the change of declination. This method of correcting one of the altitudes is particularly applicable to the case where both observations are made on the same heavenly body, and the declination does not vary but few minutes, or in extreme cases more than one or two degrees, but the same process may be used when two different objects are observed, provided their declinations are nearly equal, or do not differ more than one or two degrees.

As either one of the altitudes may be corrected, the Problem admits of two different ways of solution. For the sake of precision, the altitude which is selected to be corrected, will be called the *first altitude*; and the corresponding declination, the *first declination*; the other altitude, which is not corrected, will be called the *second altitude*, and the corresponding declination, the *second declination*. These terms, *first* and *second*, having no reference to the order in which these observations are taken, since the altitude here defined as the *first altitude* may be actually observed either *before* or *after* the other observation.

The proposed table gives for various declinations, altitudes, and latitudes, the change of the *first altitude*, corresponding to a variation of 100" in the *first declination*. Thus, with the latitude 50° N the sun's altitude 30°, and the declination 14° N the Table gives 77" for the variation of that altitude arising from a change of 100" in the declination. If the actual change of declination is greater or less than 100" the tabular number 77" must be increased or decreased in the same proportion. Thus, if the change of declination be 200", the change of altitude will be $200' \times \frac{77}{100} = 154''$. If the change of declination be 60", the change of altitude will be $60' \times \frac{77}{100} = 46''$. The correction of this *first altitude* having been found it is to be applied to the first altitude, corrected as usual, for dip, refraction, semi-diameter and parallax, and the corrected first altitude will be obtained, such as it would have been, if the declination at the time of observing that altitude had been equal to the *second declination*. With this corrected first altitude, the second altitude and second declination without correction, and the observed elapsed time, or hour angle, the computation of the latitude may be made by the *First Method*, explained in page 133.

This Table is calculated for every 2° of declination, from 0° to 96°. If the change of declination is not very great during the elapsed time, it will in general be sufficiently exact to enter the table with the nearest declination, and take proportional parts for the degrees of altitude and latitude. The latitude by account is to be used in finding the numbers from this table, it being sufficiently accurate, since an error of 1° of latitude rarely produces more than 2' change in the numbers of the Table. Suppose now, that the tabular number was required, when the latitude was 37° N the first altitude 29°, the first declination 6° 25' S. In this case, using the declination 6°, and the altitude 29°, the tabular numbers corresponding to the latitudes 30° S and 40° S. are, respectively, 77" and 73", whose difference 4" corresponds to a change of 10° of latitude, and by

T = Tab

proportion, the change corresponding to 7° of latitude is $16'' \times \frac{7}{8} = 11''.2$, this added to $57''$, gives the correction corresponding to the altitude 20° and the latitude 37° S. equal to $68''.2$. Repeating now the same operation with the altitude 30° , the two tabular numbers are $64''$ and $81''$, whose difference $17''$ multiplied by $\frac{7}{8}$ gives $11''.9$ to be added to $64''$ to get $75''.9$, the correction corresponding to the altitude 30° and the latitude 37° S. Hence it appears by changing the altitude from 20° to 30° , the correction changes from $68''.2$ to $75''.9$, increasing $7''.7$, by an increase of 10° in the altitude, the corresponding increase for a change of 8° in the altitude is equal to $7''.7 \times \frac{8}{10} = 6''.2$ nearly. This added to $68''.2$ gives $74''.4$, for the tabular number corresponding to the declination 6° , the altitude 28° , and the latitude 37° S. If the same calculation be repeated, using the declination 9° , the tabular number will be $76''.2$ instead of $74''.4$, increasing only $1''.8$ for an increase of $2^{\circ} = 120'$ in the declination, and the corresponding correction for the $25'$ of the first declination is $1''.8 \times \frac{25}{120} = 0''.4$, nearly. This added to $76''.2$ gives the correct tabular number $76''.6$, or $77''$ nearly, corresponding to the proposed latitude, 37° S. altitude 28° , or declination $6^{\circ} 25'$ S. The correction for the minute of declination is in this case small, and in general it will be so, and when the change of declination during the elapsed time is only a few minutes, it will be sufficiently exact to take out, as was directed above, the numbers corresponding to the nearest declination in the table. As there is nothing peculiar in this method of finding the corrections for the intermediate degrees of altitude and latitude (several tables in the work having been arranged upon a somewhat similar plan) it will not be necessary to go into any further detail relative to the manner of finding the number from the table corresponding to any proposed declination, altitude or latitude. The use of these numbers in finding the correction of the first altitude, is, for the sake of easy reference, drawn up in the following rules.

RULE.

1. *If the two declinations are of the same name, take their difference; if they are of different names, take their sum, and this difference, or sum, will be the change of declination corresponding to the two observations, or two objects.*

2. *Find in Table XLVIII. the number corresponding to the first declination, the first altitude, and the latitude by account. Multiply this by the change of declination, in seconds, between the two observations; the product, rejecting the two right hand figures, will be the number of seconds to be applied to the first altitude, with the same sign as in the table,* if at the second observation, the object is nearer to the elevated pole than at the first observation; but with a different sign from the Table, if at the second observation, the object is farther from the elevated pole than at the first observation.*

Thus, in the above example, where the tabular correction was $77''$, if the second altitude was 48° and the second declination $6^{\circ} 15'$ S. which is $10'$ or $600''$ less than the first declination $6^{\circ} 25'$ S. the product of $600''$ by 77 (rejecting the two right hand figures) is $462'' = 7' 42''$, being the correction to be added to the first altitude 28° , making it $28^{\circ} 7' 42''$, because the second declination is nearest to the elevated pole. If the second declination had been $6^{\circ} 35'$ S. instead of $6^{\circ} 15'$ S. the correction $7' 42''$ would be subtractive, making it $27^{\circ} 52' 18''$.

It may be observed, that the method of correcting one of the altitudes *does not alter the horary angles in any way whatever*, and the regulation of the watch used in the observation is calculated in exactly the same manner as if the correction had not been made, and whichever altitude is corrected, the result will be very nearly the same; a difference of a few seconds will sometimes be found, owing to the small quantities neglected.

To illustrate this, the following examples are given.

EXAMPLE 1.

The sun's correct central altitude was $32^{\circ} 25'$, his declination 17° N. Eight hours afterwards, by a watch, his correct central altitude was $30^{\circ} 8'$ and declination $15^{\circ} 55'$ N. Required the latitude, supposing the latitude by account $53^{\circ} 20'$ N?

The tabular correction corresponding to the first altitude $32^{\circ} 25'$, declination 17° N. and latitude by account $53^{\circ} 20'$ N. is $80''$. Multiplying this by the difference of the de-

* The signs in the Table are positive except in a few places between the tropics. In all cases without the tropics, when the distance from the elevated pole decreases, the altitude is to be increased, and when the polar distance increases, the altitude is to be decreased. The contrary takes place in those latitudes between the tropics where the tabular numbers have the sign — prefixed. It may also be observed, that the tabular number, corresponding to any possible situation of the object, cannot exceed $100''$; it was however found convenient to insert a few numbers exceeding $100''$, for the purpose of finding more accurately the proportional parts for the intermediate degrees of altitude or latitude corresponding to possible cases.

clination $17^{\circ} - 16^{\circ} 55' = 5' = 300''$, the product (rejecting the two right hand figures) is $240'.00 = 4'$, the correction of altitude. This is to be subtracted from $32^{\circ} 25'$ because the sun recedes from the elevated pole, while the declination changes from 17° N. to $16^{\circ} 55'$ N. therefore the corrected *first* altitude is $32^{\circ} 21'$. Using this with the second altitude $30^{\circ} 8'$ the second declination $16^{\circ} 55'$, and the elapsed time 8 hours, the calculation may be thus made by the *first method*, as follows—

COL. 1.			COL. 2.		COL. 3.	
Elapsed time	8h. [P. M.]	co-sec. 10.06247				
Declination	$16^{\circ} 55'$ N.	sec. 10.01921			co-sec. 10.58514	
A		co-sec. 10.04168	co-sine	9.74812	co-sine	9.74812
$\frac{1}{2}$ Sum Alt's.	$31^{\circ} 14'$	co-sine 9.93196	co-sec. 10.28512	B $31^{\circ} 18'$ N.	co-sec. 10.28426	
$\frac{1}{2}$ Diff. Alt's.	$1^{\circ} 6'$	sine 8.23850	sec. 10.00008	[B less than 90° named as decl.]		
C	$1^{\circ} 9'$	sine 8.30014	co-sine 9.99931	co-sine 9.99991		
[Z less than 90° named as bearing of zenith.]			Z sec. 10.03323	Z $22^{\circ} 8'$ N.		
				E $53^{\circ} 26'$ N.	sine	9.90480
				Latitude $53^{\circ} 25'$ N.	sine	9.90471

As it is entirely arbitrary which altitude is considered as the *first*, or the one to be corrected, it may not be amiss to repeat the operation, considering $30^{\circ} 8'$ as the *first* altitude, and $16^{\circ} 55'$ as the *first* declination. The tabular number corresponding to these quantities, and the latitude by account is $79'$ which multiplied by the change of declination $300''$ (rejecting the two right hand figures) is $237'' = 3' 57''$ or $4'$ nearly. This is to be added to $30^{\circ} 8'$ to give the corrected *first* altitude $30^{\circ} 12'$, because the Sun *approaches* the elevated pole, while his declination changes from $16^{\circ} 55'$ to 17° . Assuming, therefore, the corrected *first* altitude as $30^{\circ} 12'$, the *second* altitude $32^{\circ} 25'$, the *second* declination corresponding thereto 17° N. and the elapsed time, as before, 8 hours, the calculation may be then made as follows—

COL. 1.			COL. 2.		COL. 3.	
Elapsed time	8h. [P. M.]	co-sec. 10.06247				
Declination	17° N.	sec. 10.01940			co-sec. 10.58408	
A		co-sec. 10.08187	co-sine	9.74850	co-sine	9.74850
$\frac{1}{2}$ Sum Alt's.	$31^{\circ} 18'$	co-sine 9.93165	co-sec. 10.28429	B $31^{\circ} 27'$ N.	co-sec. 10.28386	
$\frac{1}{2}$ Diff. Alt's.	$1^{\circ} 6'$	sine 8.23850	sec. 10.00008	[B less than 90° named as decl.]		
C	$1^{\circ} 9'$	sine 8.30002	co-sine 9.99991	co-sine 9.99991		
[Z less than 90° like bearing of zenith.]			sec. 10.03278	Z $21^{\circ} 59'$ N.		
				Latitude E $53^{\circ} 26'$ N.	sine	9.90480
				$53^{\circ} 25'$ N.	sine	9.90471

So that the latitude is exactly the same by both methods.

If the middle time between the two observations was required, it would be obtained by adding the log. tangent of C 8.30263 to the log. secant of E 10.22493, whose sum, rejecting 10 in the index, is 8.52756 which sought for in the log. tangents correspond in the Col. P. M. to 0h. 15m. 26s. whose half 0h. 7m. 43s. is the middle time between the two observations. Taking the sum and difference of this and half the elapsed time, 4h. gives the times from noon when the observations were made, 4h. 7m. 43s. and 3h. 52m. 17s. the one being before noon, the other afternoon. The same result is obtained which ever altitude is corrected.

EXAMPLE II. [Same as Example XIII. page 145.]

Given the moon's correct central altitude $55^{\circ} 20'$, the moon's declination $0^{\circ} 36'$ N. The sun's correct central altitude at the same time $37^{\circ} 40'$, his declination $0^{\circ} 17'$ S. The *hour angle*, or difference of the right ascensions of the sun and moon 5 hours. Required the true latitude, the latitude by account being $23^{\circ} 20'$ N.

The tabular correction corresponding to the latitude by account $23^{\circ} 20'$ N. the sun's altitude $37^{\circ} 40'$, considered as the *first* altitude, and declination $0^{\circ} 17'$ S. is $50''$, and the change of the two declinations from $0^{\circ} 17'$ S. to $0^{\circ} 36'$ N. is $(53' =) 3180''$, this multiplied by 50, and the two right hand figures rejected, gives the correction of altitude $1590'' = 26' 30''$, this is to be added to the altitude $37^{\circ} 40'$ because the change from $0^{\circ} 17'$ S. to $0^{\circ} 36'$ N. approaches the sun to the elevated pole, therefore the sun's corrected

altitude is $38^{\circ} 6' 30''$ or simply $38^{\circ} 6'$ Using this with the moon's altitude $55^{\circ} 20'$, the moon's declination $0^{\circ} 36' N.$ and the hour angle 5 hours, the latitude may be found by the *first method*, in the following manner :

COL. 1.				COL. 2.		COL. 3.			
Elapsed time	5h.	co-sec.	10.21555						
Declination	0° 36' N.	sec.	10.00002	. . . . .		co-sec. 11.5798			
A		co-sec.	10.21557	co-sine 9.89947		co-sine 9.89947			
½ Sum Alt's.	46 43	co-sine	9.89608	co-sec. 10.13725		B 0° 45½' N.	co-sec. 11.57947		
½ Diff. Alt's.	8 37	sine	9.17558	sec. 10.00435					
C		sine	9.22723	co-sine 9.95372		co-sine 9.95372			
				Z sec. 10.03601		Z 23 0½ N.			
						E 23 46 N. sine 9.60532			
				Latitude 23° 24' N.		sine 9.59994			

This agrees with the calculation by the third method.
If the moon's altitude $55^{\circ} 20'$ had been considered as the *first* altitude and corrected, the tabular number corresponding to this altitude, the moon's declination $0^{\circ} 36' N.$ and the latitude by account $23^{\circ} 20' N.$ will be 70". Multiplying this by the change of declination 3180", and neglecting the two right hand figures, gives the correction of altitude $2226 = 37^{\circ} 6'$ or simply $37'$, which is to be subtracted from the moon's altitude $55^{\circ} 20'$ to obtain the corrected altitude $54^{\circ} 43'$, because the change from $0^{\circ} 36' N.$ to $0^{\circ} 17' S.$ makes the moon recede from the elevated pole. Using the corrected altitude $54^{\circ} 43'$ the sun's declination $0^{\circ} 17' S.$ and the sun's altitude $37^{\circ} 40'$ with the hour angle 5h. the latitude may be found by the *first method*, in the following manner :

COL. 1.				COL. 2.		COL. 3.			
Elapsed time	5 h.	co-sec.	10.21555						
Declination	0° 17' S.	sec.	10.00001	. . . . .		. . . . . co-sec. 12.50523			
A		co-sec.	10.21556	co-sine 9.89947		. . . . . co-sine 9.89947			
½ Sum Alt's.	46 11 ½'	co-sine	9.84026	co-sec. 10.14167		B 0° 21' ½ S.	co-sec. 12.50830		
½ Diff. Alt's.	8 31 ½'	sine	9.17097	sec. 10.00482.					
C		sine	9.22679	co-sine 9.99374		. . . . . co-sine 9.99374			
				Z sec. 10.03970		Z 24 7 ½ N.			
						F 23 46 N. sine 9.60530			
				Latitude		23° 24' N. sine 9.59994			

Which agrees with the preceding calculations.

EXAMPLES FOR EXERCISE.

1. The sun's correct central altitude was $41^{\circ} 33' 12''$, his declination $14^{\circ} N.$ After an interval of 1h. 30m. his correct central altitude was $50^{\circ} 1' 12''$ and declination $13^{\circ} 58' 38''$. Latitude by account $52^{\circ} 5' N.$ Required the true latitude ?
The tabular number corresponding to the altitude $41^{\circ} 33' 12''$ is 87" and this being taken for the first altitude, is also corrected $41^{\circ} 32' 0''$, the second altitude $50^{\circ} 1' 12''$, elapsed time 1h. 30m. and declination $13^{\circ} 58' 38'' N.$ These make the latitude $52^{\circ} 5' N.$
Or, by taking $50^{\circ} 1' 12''$ for the first altitude, and using the corresponding declination, the tabular number is 95", the corrected *first* altitude becomes $50^{\circ} 2' 30''$, using this with the *second* altitude $41^{\circ} 33' 12''$ the declination $14^{\circ} N.$ and the elapsed time 1h. 30. The latitude becomes as before $52^{\circ} 5' N.$
2. Given the correct central altitude of the moon $53^{\circ} 43'$, her declination $14^{\circ} 16' N.$ After an interval in which the hour angle was 1h. 44m. 15s. her correct central altitude was $42^{\circ} 29'$ and declination $13^{\circ} 52' N.$ The latitude by account $48^{\circ} 54' N.$ Required the true latitude ?
With the first altitude and first declination the tabular number is 98", and the corrected first altitude $53^{\circ} 19' 28''$, the second altitude $42^{\circ} 29'$ with which and the declination $13^{\circ} 52' N.$ and the corrected elapsed time or hour angle 1h. 44m. 15s. the latitude will be found $48^{\circ} 55' N.$

* In taking the half sum and half difference of the altitudes, it will be convenient to prove the accuracy of the calculation by adding this half sum to the half difference, for the sum will be the greater altitude. The difference of the same numbers will be the least altitude. Thus in the present example $46^{\circ} 11\frac{1}{2}' + 8^{\circ} 31\frac{1}{2}' = 54^{\circ} 43'$ the greater altitude, and $46^{\circ} 11\frac{1}{2}' - 8^{\circ} 31\frac{1}{2}' = 37^{\circ} 40'$ the least altitude.

Or, by taking $42^{\circ} 29'$ for the first altitude, and $13^{\circ} 52' \text{ N.}$ for the first declination, the tabular correction will be $83''$, the corrected first altitude $42^{\circ} 49'$, using this and the second altitude $53^{\circ} 43'$, the corresponding second declination $14^{\circ} 16' \text{ N.}$ and the hour angle $1\text{h. } 44\text{m. } 15\text{s.}$ the latitude will be found $48^{\circ} 54' \text{ N.}$ nearly agreeing with the former calculation.

3. Given the correct central altitude of the moon $55^{\circ} 38'$, her declination $0^{\circ} 20' \text{ S.}$ After an interval in which the hour angle was $5\text{h. } 30\text{m. } 49\text{s.}$ her correct central altitude was $29^{\circ} 57'$, and her declination $1^{\circ} 10' \text{ N.}$ The latitude by account $23^{\circ} 25' \text{ S.}$ Required the true latitude?

With the first altitude $55^{\circ} 38'$ and the first declination $0^{\circ} 20' \text{ S.}$ the tabular correction is $71''$ and the first corrected altitude $54^{\circ} 34' 6''$. Using this with the second altitude $29^{\circ} 57'$, the second declination $1^{\circ} 10' \text{ N.}$ and the hour angle $5\text{h. } 30\text{m. } 49\text{s.}$ the true altitude will be found $23^{\circ} 23' \text{ S.}$

Or, by taking $29^{\circ} 57'$ for the first altitude, and $1^{\circ} 10' \text{ N.}$ for the first declination, the tabular correction will be $45''$ and the first corrected altitude $30^{\circ} 37'$. Using this with the second altitude $55^{\circ} 38'$ the second declination $0^{\circ} 20' \text{ S.}$ and the hour angle $5\text{h. } 30\text{m. } 49\text{s.}$ the true latitude will be found to be $23^{\circ} 24' \text{ S.}$ nearly agreeing with the preceding calculations.

In making the calculations of these three examples the seconds were noticed, which is always best to be done, particularly when the altitudes are nearly equal; some difference might be found in the above results if the nearest minutes only were taken. Thus, Example XII. page 144, calculating to the nearest minute, only gives the latitude $55^{\circ} 27'$. If the calculation be made as in Ex. I. of this appendix, it becomes $55^{\circ} 25'$, differing $2'$. This would be avoided by taking the angles to seconds, and in some extreme case it would require the use of 6 or 7 places of decimals.

TABLE XLVIII.

TABLE showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. If the change moves the body towards the elevated pole, apply the correction to the altitude with the sign in the Table; otherwise, change the sign.

		LATITUDE Of same name as declination.								LATITUDE Of different name from declination.									
Dec.	Alt.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Alt.	Dec.	
0°	0°	94	87	76	64	50	34	17	0	17	34	50	64	76	87	94	0	0°	
	10	95	88	78	65	51	35	18	1	18	35	51	65	78	88	95	10	0°	
	20	100	92	89	68	53	36	18	0	18	36	53	68	82	92	100	20	0°	
	30		100	88	74	57	39	20	0	20	39	57	74	88	100		30	0°	
	40			100	84	65	45	22	1	23	45	65	84	100			40	0°	
	50				100	78	53	27	0	27	53	78	100				50	0°	
	60					100	68	35	0	35	68	100					60	0°	
70						100	51	0	51	100							70	0°	
2°	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	2°	
	10	95	87	77	65	50	34	17	-1	18	35	51	66	78	88	96	10	2°	
	20	99	91	81	67	52	35	17	-1	19	37	54	69	83	93	101	20	2°	
	30	107	98	87	73	56	38	18	-2	22	41	59	76	90	102		30	2°	
	40		111	98	82	63	42	20	-2	25	47	68	86	102			40	2°	
	50			116	97	74			-3	30	57	81	103				50	2°	
	60				124	95	64	30	-5	40	73	102					60	2°	
70					139	92	43	-8	59	108							70	2°	
4°	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	4°	
	10	94	87	77	64	50	34	16	-1	19	36	52	67	79	89	97	10	4°	
	20	98	91	79	66	51	34	16	-3	21	39	56	71	84	95	103	20	4°	
	30	105	96	85	70	54	36	16	-4	24	44	62	78	93	104		30	4°	
	40		107	94	78	59	39	17	-6	29	51	71	90	106			40	4°	
	50			111	92	70	45	19	-8	35	62	86	109				50	4°	
	60				117	88	56	23	-12	47	81	112					60	4°	
70					127	51	32	-19	70	119							70	4°	
6°	0	94	87	77	65	50	34	17	-0	17	34	50	65	77	87	94	0	6°	
	10	94	87	76			33	16	-2	20	37	53	67	80	90	98	10	6°	
	20	99	89	78	65	50	33	15	-4	22		57	73	86		104	20	6°	
	30	103	94	83	69		34	14	-6	26	46	64	81	95	107		30	6°	
	40		105	92	77	57	36	14	-9	31	54	74	93	109			40	6°	
	50			107	88	66	41	15	-13	40	66	91	113				50	6°	
	60				111	82	51	17	-18	53		119					60	6°	
70					118	72	22	-29	80	129							70	6°	
8°	0	95	87	77	65	50	35	18	-0	18	35	50	65	77	87	95	0	8°	
	10	94	86	76	63	49	33	15	-3	20	38	54	68	81		99	10	8°	
	20	96	88	77	64	49	32	14	-5	24	40	59	74	87	98	106	20	8°	
	30	101	93	81	67	50	32	12	-8	28		66		97	109		30	8°	
	40		102	89	73	54	33		-12	35	57	78	97	111			40	8°	
	50			104	84	62	37	11	-17	44	70	95	118				50	8°	
	60				105	77	45	11	-24	59	93	125					60	8°	
70						62		-39	90	130							70	8°	
10°	0	95	88	78	65	51	38	18	-0	18	35	51	65	78	88	95	0	10°	
	10	94	86	75	63	48	32	15	-3		38	55	69	82	92	100	10	10°	
	20	95	87	76	63	48	31	12	-6	25	43	60	76	89	100		20	10°	
	30	100	91	80	65	49	30	10	-10	30	50	69	86	100			30	10°	
	40		100	87	70	51	31	8	-15	38	60	81	100				40	10°	
	50			100	81	58	33		-21		75						50	10°	
	60				100	71	39	5	-31	66	100						60	10°	
70					100	53		-49	100								70	10°	
12°	0	96	89	78	66	51	35	18	-0	18	35	51	66	78	89	96	0	12°	
	10	94	86	76	63	48	32	14	-4	22		56	70	83	94	101	10	12°	
	20		86	76	62	47	29	11	-8	27	45		78	91	102		20	12°	
	30		90	78		47	28	8	-12	33	53	71	88				30	12°	
	40	108	93	84		49	28	5	-18	41	63	85					40	12°	
	50		111	97	77	54			-25	53		105					50	12°	
	60			111	95	65	33	-1	-37	72	107						60	12°	
70				134	91	44	-6	-68	110								70	12°	
Dec.	Alt.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Alt.	Dec.	
		LATITUDE Of same name as declination.								LATITUDE Of different name from declination.									

TABLE XLVIII.

617

TABLE showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. If the change moves the body towards the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

Alt.	LATITUDE Of same name as declination.															LATITUDE Of different name from declination.															Alt.	Dec.
	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°		
0	97	89	79	66	52	37	19	0	18	35	52	66	79	89	97	0															0	
10	94	86	76	63	48	31	14	-4	23	40	57	72	85	95	103	10															10	
20	91	83	73	60	45	28	7	-9	28	45	64	80	91	104		20															20	
30	87	79	69	56	41	25	0	-14	35	55	74	91	106			30															30	
40	84	76	66	53	38	22	-2	-21	42	62	83	107				40															40	14°
50	80	72	62	49	35	19	-7	-30	58	85	110					50															50	
60	76	68	58	45	32	16	-13	-43	79	114						60															60	
70	71	63	53	40	27	11	-16	-59	121							70															70	
0	98	90	80	67	52	37	18	-0	18	36	52	67	80	90	98	0															0	
10	94	86	76	63	48	31	11	-5	23	41	58	73	86	96	104	10															10	
20	91	83	73	60	45	27	4	-10	30	48	66	82	95	106		20															20	
30	87	79	69	56	41	24	0	-17	37	58	77	94	109			30															30	
40	84	76	66	53	38	21	-4	-24	48	70	91	111				40															40	16°
50	80	72	62	49	35	18	-9	-34	62	85	115					50															50	
60	76	68	58	45	32	15	-14	-50	85	121						60															60	
70	71	63	53	40	27	11	-26	-79	132							70															70	
0	99	91	81	68	53	36	13	-0	18	36	53	68	81	91	99	0															0	
10	95	87	77	64	49	33	6	-6	24	42	59	76	88	98	106	10															10	
20	93	85	75	62	47	30	0	-12	31	49	66	83	95	109		20															20	
30	90	82	72	59	44	27	-3	-19	40	58	77	97	112			30															30	
40	87	79	69	56	41	24	-8	-27	51	74	96	116				40															40	18°
50	83	75	65	52	38	21	-13	-39	67	95	121					50															50	
60	79	71	61	48	35	18	-20	-56	85	128						60															60	
70	74	66	56	43	30	15	-36	-89	132							70															70	
0	100	92	82	69	54	39	18	-0	18	36	53	69	82	92	100	0															0	
10	95	87	77	64	49	34	12	-6	25	43	60	76	89	100		10															10	
20	93	85	75	62	47	31	6	-13	33	52	70	86	100			20															20	
30	90	82	72	59	44	28	0	-21	42	63	81	100				30															30	
40	87	79	69	56	41	25	-6	-31	55	78	100					40															40	20°
50	83	75	65	52	38	22	-15	-43	72	100						50															50	
60	79	71	61	48	35	19	-26	-63	100							60															60	
70	74	66	56	43	30	16	-46	-100								70															70	
0	93	85	75	62	47	32	19	-0	19	37	54	69	83	93	101	0															0	
10	89	81	71	58	43	28	12	-7	26	45	62	78	91	102		10															10	
20	85	77	67	54	39	25	6	-15	35	54	72	88	103			20															20	
30	81	73	63	50	35	22	-2	-23	45	66	86	103				30															30	
40	77	69	59	46	31	19	-9	-34	58	82	104					40															40	22°
50	73	65	55	42	28	16	-19	-48	77	106						50															50	
60	69	61	51	38	25	13	-33	-70	107							60															60	
70	64	56	46	33	20	10	-56	-111								70															70	
0	95	87	77	64	49	34	19	-0	19	37	55	70	84	95	103	0															0	
10	91	83	73	60	45	30	11	-8	27	47	64	81	93	104		10															10	
20	87	79	69	56	41	26	4	-16	36	58	77	91	107			20															20	
30	83	75	65	52	38	22	-4	-26	48	69	89	107				30															30	
40	79	71	61	48	35	19	-12	-37	62	86	109					40															40	24°
50	75	67	57	44	31	16	-23	-53	81	111						50															50	
60	71	63	53	40	27	13	-39	-77	115							60															60	
70	66	58	48	35	22	10	-67	-122								70															70	
0	96	88	78	65	50	35	19	-0	19	38	56	73	85	96	105	0															0	
10	92	84	74	61	46	31	11	-9	28	47	65	82	95	106		10															10	
20	88	80	70	57	42	27	4	-18	38	58	77	94	108			20															20	
30	84	76	66	53	38	23	-6	-28	50	70	92	111				30															30	
40	80	72	62	49	35	19	-16	-41	66	91	114					40															40	26°
50	76	68	58	45	32	16	-28	-58	88	117						50															50	
60	72	64	54	41	28	13	-46	-84	123							60															60	
70	67	59	49	36	23	10	-78	-134								70															70	
Lat.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Alt.	Dec.															

New Form of Table XX. for working a Lunar Observation.

SINCE the former part of this work was printed, a new form has been given to Table XX. by which the last corrections of a Lunar Observation may be found very expeditiously. The correction in this new Table will frequently exceed those deducted from the former one by two or three seconds, on account of having introduced the fourth and fifth corrections, which were formerly omitted.

In using this new Table, it will in general be sufficiently accurate to find the nearest altitudes and distance, and take out the corresponding correction, without the trouble of making a proportion for the neglected degrees and minutes. Thus in Example I. enter the new table with the \star 's altitude 50° , β 's altitude 70° , distance $50'$, which are the nearest numbers in the Table, the corresponding correction is $27''$, as found before. In the second example the \star 's altitude 10° , β 's 20° , distance $50'$, give the correction $27''$, being $4''$ more than the former method. In the third example the correction is $24''$. In the fourth $22''$. In the fifth $17''$. In the sixth $19''$. These corrections are always additive.

In using the second and third methods of working a lunar observation, this correction is to be found in the same manner, and added to the corrected distance, subtracting $18''$ from the sum. Thus, in Example I. the correction $20''$ is to be added, and the constant quantity $18''$ subtracted, leaving $2''$ to be added instead of $1''$, found by the former method.

TABLE XX. (New Form.) Correction in Seconds, additive.

True distance of the Moon from the Sun or a Star.

Star Alt.	Dist.	20°	25°	30°	35°	40°	45°	50°	55°	60°	70°	80°	90°	100°	110°	120°	Star Alt.
10°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	10°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	20°
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	30°
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	40°
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	50°
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	60°
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	70°
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	80°
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	90°
20°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	20°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
30°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	30°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
40°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	40°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
50°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	50°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
60°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	60°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
70°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	70°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
80°	10°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	80°
	20	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	30	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	40	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	50	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	60	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	70	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	80	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	90	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	

END OF THE APPENDIX.

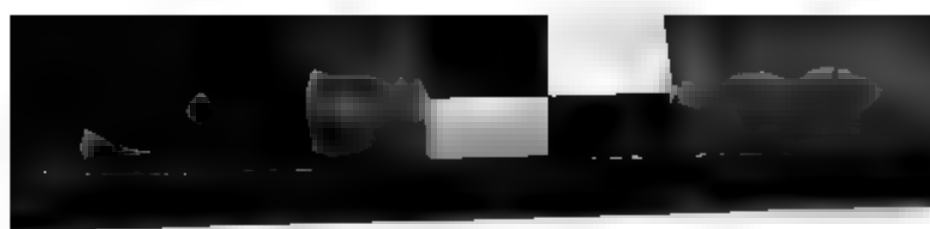


CHART AND QUADRANT STORE.

EDMUND AND GEORGE W. BLUNT,
HYDROGRAPHERS,
 HAVE OPENED A CHART AND QUADRANT STORE,
 No. 149 FLY-MARKET-STREET,

One door above the North corner of Front-Street, NEW-YORK; where, by personal attention to business, they hope to receive that patronage which industry and perseverance merit. They have for sale—

BOOKS:

OWDITCH'S PRACTICAL NAVIGATOR, 6th edition, stereotyped.
 LUNT'S AMERICAN COAST PILOT, 10th edition.
 THE MERCHANT'S AND SHIP-MASTER'S ASSISTANT, containing information useful to merchants, masters of ships, &c.
 NAUTICAL ALMANACS, from the year 1811 to 1828, both inclusive—to be continued annually. Explanation stereotyped, and English copy corrected.
 SEAMANSHIP AND NAVAL TACTICS, second edition.
 YARD'S LUNAR TABLES.

CHARTS:

- NEW CHART, extending from New-York to Havana, including Bahama Banks and Channels, improved by actual surveys of the Chesapeake Bay, by order of the Navy Department, and of Capes Hatteras, Look Out, and Fear Shoals, in conformity to an act of Congress of the United States, and conducted under the direction of J. D. ELLIOT, Esq. Capt. in the U. S. Navy, and by permission of Hon. SMITH THOMPSON, Secretary of the Navy, copied, and contains all the Surveys made on the Coast of North Carolina, to the present time (1826.) This Chart has been since improved by a survey from Sandy Hook to Cape May, under the direction of Capt. JONATHAN COLESWORTHY, and EDMUND BLUNT, Hydrographer. It has also several PLANS of HARBOURS, from actual surveys.
- NO. of the Mississippi River, extending to New-Orleans, including Mobile, &c. with sailing directions, and plan of Mobile, on a large scale, from actual survey.
- NO. of Bahama Banks, from actual survey, made in sloop Orbit, in 1820, with sailing directions.
- NO. from New-York to Nova Scotia, extending from latitude 38° N. to latitude 47° N. longitude 69° W. to longitude 74° W. including the whole of St. George's Bank, improved to August, 1821, by government and other surveys, by which the latitude of the South Shoal of Nantucket was found 22' wrong, and is here, for the first time, published correct.
- NO. of the Atlantic or Western Ocean, improved to 1820, with an Analysis of the authorities upon which the dangers have been inserted on the Chart. The Tracks extend to the Equator, and are continued on the Chart of the South Atlantic Ocean. This is the only general Chart extant which has the latitude of the South Shoal of Nantucket within 22 miles correct.
- NO. of the South Atlantic Ocean, containing more authentic information than any extant, part of which describes dangers lately discovered, with original plans of harbours and views.
- NO. of the North Coast of Brazil, showing the entrances and courses of the Rivers Para and Amazon.
- DO. of the West-Indies, on four sheets, which may be had separate.
- DO. of the Coast of Guyana.
- DO. of the Coast of Brazil.
- DO. of the Island of Bermudas, with sailing directions on the chart.
- DO. of Long Island Sound, improved to 1821.
- DO. of the Coast of Labrador.
- DO. of Newfoundland.

PLAN of New-London Harbour, surveyed by CHARLES MORRIS, Esq. of the United States Navy, by order of Commodore RODGERS, and to him respectfully dedicated.

Repeating Circles; Brass Sextants, with Telescopes complete, in mahogany cases; Brass Sextants for the pocket; Ebony Sextants; Quadrants of superior make, with Telescopes; ditto without; Artificial Horizons; Steering, Storm, Amplitude, Azimuth, Pocket and Hanging Compasses, Day Telescopes for sea or land; Night and Day Telescopes; Night Telescopes, either to invert the object or show it erect; Cases of Instruments for Navigation and Drawing in general; Scales and Dividers, Common and Sliding Gunter's Scales; Mast-makers', Ship-carpenters', and Cordage Rules; Marine and Common Thermometers; Log and Time Glasses; Bar and Compound Magnets;

Jack and Pen-Knives of various kinds ; Writing and Letter Paper ; Ink and Ink Powder ; Lead and Slate Pencils ; Log and Account Books ; Seamen's Journals :—with every article in the stationary line useful at sea.

Also, every CHART and NAVIGATION BOOK required by gentlemen navigating any part of the globe, it being their sole object to furnish an universal assortment on the most reasonable terms.

Compasses, Sextants, Quadrants, Thermometers, Barometers, and Spy Glasses correctly repaired ; and orders left at their store will be punctually attended to by sending for the article, and when repaired, carefully returned.

Cash given for second hand Instruments.

Published by E. & G. W. BLUNT,

PLAN of New-York Harbour, from actual survey, and which may be used with the greatest confidence when a Pilot cannot be obtained, also—a second edition of WARD'S Lunar Tables.

Preparing for Publishing,

Which will appear at the commencement of the year 1827, a CHART of the Coast of North America, on a Scale, and with such improvements, as are not to be found on any extant.

May, 1826.

NOAH T. PIKE,

Draper, Mercer, and Merchant Tailor,

No. 319 Pearl-Street NEW-YORK, Franklin-Square,

Respectfully informs the public in general, that he has constantly on hand (at his establishment) a choice assortment of fashionable Cloths, Cassimeres, and Vestings, of a handsome variety and taste.

He would, in particular, inform those who may please to favour him with patronage, that his goods are constantly of such variety in style and quality, as is calculated to accommodate his customers with any article of CLOTHING in his line, suitable for any season of the year, which he will guarantee to furnish them with at the shortest notice, executed in the most durable and fashionable style, and on the most reasonable terms.

He thus solicits, as he hopes to merit, a generous share of public patronage.
April, 1826.

LOOKING GLASSES.

The New-York Looking Glass Manufacturing Company, No. 20 Wall-street, respectfully inform Shippers, Country Merchants and the public in general, that they are now ready to supply them with Mantel and Pier Looking Glasses, of every size and variety of pattern, equal in quality to any offered in this city, and at the most reduced prices. Those therefore, who wish to purchase, will find it to their advantage to call and examine for themselves.

Masters of Vessels, having orders for the above articles, may depend on that punctuality and liberality in prices, which will ever give satisfaction, and the greatest attention will be paid in packing.

New-York, April, 1826.

M. O'CONNOR, Agent.

HALF-PRICE BOOK-STORE,

No. 4 South Front-street, PHILADELPHIA.

Books in almost every department of literature may be bought at the Half-Price Book-Store, at an average of about one-half the usual retail prices. Scarce and copyright books, which cannot be afforded so low, will, in every instance, be sold at the lowest prices.

Blank Books, Paper, Quills, Inkpowder, and a general assortment of Stationary.

NAUTICAL BOOKS.

Blunt's Coast Pilot, Bowditch's Navigator, Nautical Almanacs, Ship-Master's Assistant, Charts, &c.

Passengers and others, who may want Books to amuse themselves with during their leisure hours, may often buy here such as Novels, Magazines, or other light reading, much lower than half or even one-fourth the nominal prices.

May, 1826.

WASHINGTON HALL.

M'INTYRE, Washington Hall, 282 Broadway, corner of
Reed-street, New-York,

Respectfully informs the public, he is at all times ready to accommodate with BOARD and LODGING private families, and gentlemen who may resort to this city for business or pleasure, and with confidence assures them, his establishment is not exceeded by any other in the city for convenience and comfort ; and being in the neighbourhood of the Theatre, Museum, City Hall, and places of amusement, he flatters himself in giving the greatest satisfaction.

May, 1826.

JOHN J. RICKERS,

IMPORTER AND MANUFACTURER OF

PIANO FORTES, &c. AND MUSIC SELLER,

No 187 BROADWAY, NEW-YORK.

Piano Fortes repaired in a very superior style.

May, 1826.

WILLIAM H. PRIEST'S

JEWELLERY AND WATCH STORE.

No. 189 Broadway, opposite John-street,
NEW-YORK.

A general assortment of Fashionable Jewellery, Silver, Plated, and Britannia Ware, Fine Cutlery, Clocks, Watches, and Fancy Articles.

* * * Particular attention paid to Watch Repairing.

April, 1826.

MERCHANT TAILORS.

ALEXANDER DOUGHERTY & SON, Merchant Tailors, No. 39 South Front-Street, PHILADELPHIA, have for sale a variety of

CLOTHING OF FIRST QUALITY.

* * * Navy and Army Officers may supply themselves on the most reasonable terms, and with the neatest fashions.

May, 1826.

CLOTHING STORE.

ALEXANDER DOUGHERTY & SON, Tailors, No. 40 South Water-street, PHILADELPHIA, have constantly on hand a regular and extensive assortment of CLOTHING, where Officers and Seamen may supply themselves on the most satisfactory terms.

May, 1826.

JAMES B. STANSBURY,

DRUGGIST.

No. 33 Thames-street, Fell's Point.

BALTIMORE,

Has for sale a general assortment of MEDICINES and DRUGS, of the best qualities, wholesale and retail.

MEDICINE CHESTS of every description, for shipping and private families put up at the shortest notice and in the neatest manner. Old Medicine Chests refitted with the greatest care and despatch, with plain and ample directions, and on the lowest terms.

May, 1826.

PETER McLAUGHLIN,

CHEAP CLOTHING STORE,

No. 59 Pratt-street, Baltimore.

☞ Fine and coarse goods made up and sold at the lowest prices.

May, 1826.

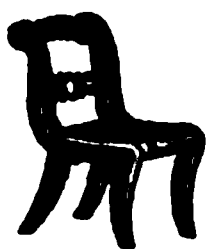
BEDDING WAREHOUSE.

No. 270 North Second-street, above the Golden Lamb,

PHILADELPHIA.

BENJAMIN O. HODGES, respectfully informs his friends and the public in general, that he keeps on hand a constant supply of Beds and Bedding, Mattresses of all kinds, Sacking-Bottoms—*FEATHERS* of the best quality, Curled Hair, Moss, Flocks, Cat-tails, Cotton, Wool, and a general assortment of *CABINET WARE*, such as Bedsteads, Bureaus, Tables, Sideboards, Children's Cribs, Cradles, Wash-stands, &c. and a general assortment of *CHAIRS*, and a number of other articles in his line, all of which he will sell on reasonable terms. Young persons who are about to commence house-keeping will find it to their advantage to call and see his assortment, and Ship-Masters will be furnished on the most liberal terms.

May, 1826.



TWEED & BONNEL,

Fancy and Windsor Chair Manufacturers,

No. 2 Cherry-street, one door from Dover-street,

NEW-YORK,

Orders thankfully received, and executed with punctuality and despatch. A liberal allowance made to shippers.

Old Chairs repaired, painted, and regilt.

April, 1826.

J. W. DURYEE,

DRUGGIST.

No. 206 Pearl-street, next door to the corner of Fly-Market-slip

NEW-YORK,

Has for sale a general assortment of Drugs, Medicines of all kinds, Perfumery, Dyers' and Fullers' articles, Patent Medicines, &c. of the best qualities and low prices.

MEDICINE CHESTS put up and repaired with care and despatch, by a professional character, and all orders left at 206 Pearl-street, will be promptly attended to.

May, 1826.

ISAAC W. GOODRICH,

STATIONER,

No. 76 State-Street—Boston, (Mass.)

Has for sale, Ledgers, Journals, Cash, Sales, Invoice, and Letter-Books, ruled and bound, in the neatest manner; Paper, warranted of the very first quality, prices low; English, Italian, and American writing paper; Letter, do.; Dutch, English, and American Quills; Ink powder; Wax, Wafers; Red and Black Ink; Penknives, of Rodger's manufacture, 150 different patterns, one to eight blades, 12 cents to \$5 each; John Barber's Old English Razors, warranted good, or money returned; Emerson's Razor Strops, superior to any in use; Playing Cards, by groce, dozen, or single pack, at manufacturer's prices; Day & Martin's Real Japan Liquid Blacking, by cask, dozen, or single jug; Bowditch's new edition Navigator; Blunt's American Coast Pilot; Nautical Almanacs; Ready Calculators; Sailors' Physician; Seaman's Journals, printed forms, any size or thickness, bound.

Merchants will always find a complete assortment of blanks, such as Checks, Bills Lading, Entries, Manifests, Shipping papers, &c. &c. Account Books, in sets, ruled and bound to any pattern. Old books re-bound.

I. W. G. has a manufactory of *Calf-Skin Pocket Books*, and can furnish them in a style superior to any manufactured in the United States, and as low. Purchasers are invited to call and examine for themselves.

* * Sea-faring persons can be supplied with Stationary, Nautical Books and Charts, by sending their orders, and on as good terms as can be purchased for in Boston. Store open till 9 o'clock evenings. Goods sent to any part of the town, gratis.

April, 1826.



EDMUND HAVILAND.
IMPORTER OF
CHINA, GLASS AND EARTHENWARE,

HAS constantly on hand an extensive assortment of FINE CUT and FLAIN GLASS, CHINA and EARTHENWARE, at the lowest prices, by the package or less quantity, at his store

No. 306 Pearl street, just below Peck-slip, New-York.

N. B. The most approved articles and patterns for ship's use

May, 1826.

CABINET WAREHOUSE.

No. 48 Canal-street,

HENRY M. BRITON informs the public that he has constantly on hand, an extensive assortment of Furniture of every description in his line together with Mahogany Chairs of the first style, all of which he will dispose of on the most reasonable terms.

A share of the public patronage is solicited

New-York, May, 1826.

S. HUTCHINSON.
CABINET MAKER,

No. 48 Canal-street, New-York.

Sideboards, Secretaries, Sofas, Dining, Breakfast and Card Tables, &c. &c. of the newest fashions, and made of the best materials constantly for sale—or made to order, on the most accommodating terms

May, 1826.

PIANO FORTES.

T. LOUD,—PIANO FORTÉ MAKER from London, respectfully informs the public that he has replenished his stock, and has for sale a handsome assortment of very superior Piano Fortes of touch and tone, seldom to be equalled—one of which, just finished, with four pedals, is of unusual and unrivalled splendor, united with real excellence. Merchants visiting the city, would consult the interest of themselves and friends, (from whom they may have brought order) by examining the above. Prices moderate, and all Pianos warranted. Pianos tuned and repaired, and old ones taken in exchange. No. 302 Canal-street, (between Broadway and Lafayette Circus.)

April, 1826.

FIRTH & HALL,
Musical Instrument Makers, and Importers of
ALL KINDS OF MUSICAL MERCHANDISE,
No. 358 Pearl-street, near Franklin-square,
NEW-YORK,

Have constantly for sale an assortment of Piano Fortes and Musical Instruments of the most celebrated Makers and of their own manufacture together with every other article of Musical Merchandise, wholesale and retail, on the most liberal terms. BANDS supplied with Instruments &c. Musical instruments of all kinds tuned and repaired in the neatest manner. All orders thankfully received and attended to with care and despatch.

April, 1826.

N. KNIGHT,
BOOK, STATIONARY, AND VARIETY STORE.

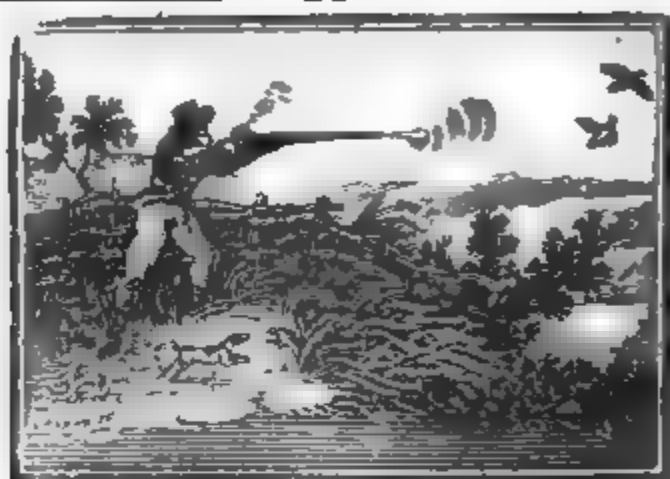
Thames-street, late Fell-street, Fell's Point.

April 1826

BALTIMORE.

CABINET WAREHOUSE. BOSS & FAIRCHILD

Beg leave to inform their friends and the public that they have commenced the CABINET MAKING business at their Warehouse, No. 607 Broadway, where all orders will be thankfully received and punctually attended to: they will also find a large assortment of imitations of wood of all descriptions, painted by one of the first painters in the country.
April, 1826.



A GENERAL ASSORTMENT OF
SPORTING TACKLE,
WHOLESALE AND RETAIL,
AT ISRAEL HORSFIELD'S HARDWARE STORE,
No. 230 Water-street, New-York.

Fishing Tackle.—Fish rods, swivels, shrimp nets, India grass, hair, gut and flax lines, brass and wood reels, floats, sinkers, gentlemen's fish cars, silkworm gut, single and twisted, Kirby and taper point fish-hooks fastened on gut, grass, hair, and flax twine, Patent spring pickerel, R. Hemming & Son's royal improved cast, and best steel Kirby, taper point mussel, mackerel, whiting, cod, and sea fish-hooks, stamped I. P.

Shooting Tackle.—Dartford canister, English and American gunpowder, patent shot, shot bags, powder flasks, horns, game bags, gun worms, locks, &c. &c.

ALSO, A GENERAL ASSORTMENT OF HARDWARE.

May, 1826.

FLOUR STORE.

The subscribers have constantly on hand and for sale at No. 223 Front-street New-York, a large and general assortment of New-York Canal, Philadelphia, Baltimore, and Richmond Superfine and Fine FLOUR—Also, Rye, Indian, and Buckwheat MEAL, which they sell at the lowest market prices, and warrant all Flour sold by them to be equal to the representation.

Merchants, Masters of vessels, and private families, will always be supplied with a superior article.

New-York, April, 1826.

NEWELL & PARSONS,

No. 223 Front-st. near Peck-slip.

. SELDEN BRAYNARD'S

Lottery and Exchange Office, No. 16 State-street, Boston.

FIVE DOORS ABOVE THE BRANCH BANK,

Where have recently been sold the following Capital Prizes, viz:—

1	Prize of	\$50,000	97	Prizes of	\$10,000
2	do.	15,000	84	do.	500
4	do.	10,000	218	do.	100
6	do.	5,000	318	do.	50

The Capital Prize of \$50,000 is the highest ever sold in Boston; and the cash was advanced on presentation of the ticket at the above office, on the day the drawing was received. Tickets may be had in all the Lotteries drawn in the United States, and the cash paid for prizes soon as drawn.

Orders enclosing cash (post paid) will meet with immediate attention.

May, 1826.

CARPETING.

J. & J. H. SACKETT,

Offer for sale at their Store, 96 Division-st., nearly opposite Market-st.

An extensive assortment of VENETIAN, BRUSSELS, and ENGLISH INGRAIN-ED CARPETING, large and elegant patterns, of all qualities; Nankin and Canton Matting; Brussels, Wilton and Imperial Rugs; Table and Piano Covers, &c. &c.

Merchants and Ship-Masters, in furnishing ship's cabins, will find it greatly for their interest to apply as above.

N. B. Also—a splendid assortment of light Carpeting, patterns and quality equal to any ever imported, at prices which will be an object to those who are in want of the above articles.

New-York, April, 1826.

YORK HOUSE,

NOS. 5 AND 7, COURTLANDT-STREET,

NEW-YORK,

BY A. YOUNG.

May, 1826.

GILBERT' & SONS,

EXCHANGE-STREET, BOSTON.

U. S. Stocks,
Bank Stock,
Inland Exchange,
Notes of Hand, &c.,

} Negotiated.

Dollars,
Doubloons,
Foreign Gold,
Bank Notes,

} Bought and Sold.

LOTTERY TICKETS in all legally authorized Lotteries, constantly for sale.—Attend generally to all business relating to Stock Exchange, Money and Lottery Brokers.

April, 1826.

J. HORSPOL,

CABINET, CHAIR, AND SOFA

MANUFACTURER,

16 WHITE-ST.

J. H. assures the public, that all orders in his line will be attended to with punctuality and despatch.

Orders from the Southward will meet with immediate attention.

New-York, May, 1826.

WILLIAM BIGELOW,

BOOKBINDER,

No. 50 Fulton-street, BROOKLYN.

BOOKBINDING, in all its various branches, executed with neatness and despatch.

Merchants' Account Books, Writing Books, &c. ruled to patterns at the shortest notice.

Backgammon Tables, Chess Boards, Battledores, Dice Boxes, &c. wholesale and retail.—Maps, Pictures, &c. varnished in the neatest manner.

Brooklyn, 1826.

G. & R. WAITE'S LOTTERY AND EXCHANGE OFFICES,

Corner of Broadway and Maiden-lane, and the corner of Broadway and Fulton-street, New-York—south-west corner of Third and Chesnut-streets, Philadelphia—and corner of Charles and Market-streets, Baltimore. At all the above offices, Bank Notes are discounted at the lowest rates, and the highest premium given for Gold. Tickets and shares in all the Lotteries for sale. Cash advanced for prizes as soon as drawn. At Waites' offices have been sold and paid Prizes amounting to EIGHT MILLIONS OF DOLLARS.

April, 1826.

NATIONAL HOTEL.

The public is respectfully informed, that the splendid edifice recently erected in the city of New-York, by Joseph Delacroix, Esq. is opened for their accommodation.—This establishment is situated in one of the most airy and agreeable parts of Broadway, nearly opposite the City Hotel, was built expressly for a house of public accommodation, and is believed to possess advantages for rendering a residence to strangers of business or pleasure, pleasant and comfortable, not surpassed in this country.

The Leasers, anxious to render the National Hotel alike creditable to themselves and to this commercial metropolis, have spared no exertion or expense, to finish the establishment in a style they are fully confident will secure public approbation and support. Its immediate superintendence is confided to Mr. E. BOARDMAN, a gentleman whose experience and capacity of conducting a concern of this kind are well known to the public, and renders any pledge on the part of the proprietors for its proper management, unnecessary.

Extensive arrangements have been made for the reception of permanent BOARDERS, and the accommodation of gentlemen with their families, with private suits of apartments.
May, 1826.

GEDNEY KING, MATHEMATICAL INSTRUMENT MAKER, NO. 118 State-Street, opposite Broad-Street, BOSTON,

Has constantly for sale, wholesale and retail, a general assortment of Mathematical and Philosophical Instruments, of the best quality, (warranted,) comprising articles of almost every description in the mathematical line, viz :—

Sextants of ebony and metal, with silver, brass and ivory arches—Quadrants, with and without tangent and vertical screws—Day and Night Telescopes, with and without brass shades, and Telescopes of every description—azimuth, amplitude, storm, brass, and wood binnacle, hanging, and pocket Compasses—Binnacle Lamps, Time Glasses of every quality, Thermometers, Marine Barometers, Scales and Dividers, Parallel Rules, Protractors, cases of Instruments, &c. &c.

Bowditch's Practical Navigator, Blunt's American Coast Pilot, do. Seamanship and Naval Tactics, do. Nautical Almanacs, Shipmaster's Assistant, Merchant and Seaman's EXPEDITIOUS MEASURER, consisting of a set of Tables, which shew at one view the Solid Contents of all kinds of packages and casks, according to their several Lengths, Breadths, and Depths : also, Rules for determining the contents of all sorts of casks in wine and beer measure—Stereotype Edition ; Corrected by EDMUND M. BLUNT, Author of the American Coast Pilot, &c.—WARD'S Lunar Tables, together with every Nautical publication of merit, including an assortment of the most useful CHARTS.

Sextants, Quadrants, Compasses, Time Glasses, and other Instruments, cleaned and repaired at the shortest notice, and on the most reasonable terms.

April, 1826.

J. M. ELFORD'S CHART AND MATHEMATICAL STORE, No. 119 East Bay, sign of the Quadrant, CHARLESTON, S. C. OLD ESTABLISHED STAND.

FOR SALE—Charts, Nautical Books, and Mathematical Instruments of every description. Compasses, Quadrants, Spy-Glasses, &c. repaired and for sale. Chronometers rated.

Published and for sale, J. M. Elford's LONGITUDE TABLES, being the shortest and most simple method of working Lunar Observations of any in practice. Elford's Circular POLAR TABLES, for finding the Latitude at any time of night by an Altitude of the Polar Star. Elford's Universal and Perpetual Circular TIDE TABLES, for finding the time of High Water every day in the year, at all the principal places in the world, by inspection or at sight. Also—The UNIVERSAL SIGNAL BOOK, with improvements, by J. M. Elford.

NAVIGATION taught in all its branches, including Astronomical and Lunar Observations.

N. B. An EVENING SCHOOL from 6 till 9—and private lessons given upon Lunar Observations at intervals.
April, 1826.

BAROMETERS AND THERMOMETERS,

WHOLESALE AND RETAIL.

CHARLES POOL,

BAROMETER AND THERMOMETER MAKER,

No. 280 $\frac{1}{2}$ Broadway,

Next door to Washington Hall,

NEW-YORK,

Respectfully acquaints his friends and the public, that he has to offer for inspection, Parlour, Marine, and Mountain Barometers with a large assortment of Thermometers, suitable for Brewers, Distillers, Chymists, Sugar Bakers, Dyers, Bath, Botanical and Marine purposes. Likewise, Hydrometers Saccharometers, Plate Electrical Machines, compound Microscopes, Telescopes, and a general assortment of Spectacles, suitable for all ages.

N. B. Barometers and Thermometers accurately repaired.

April, 1826.



THIMBLE MANUFACTORY.

GEORGE W. PLATT

CONTINUES HIS MANUFACTURING ESTABLISHMENT, AT

NO. 361 PEARL-STREET,

NEW-YORK.

Where he offers for sale a great variety of Gold and Silver Thimbles, Fancy articles, &c.

N. B. All orders will be thankfully received, and punctually attended to.

April, 1826.

FASHIONABLE CLOTHING STORE,

No. 153 $\frac{1}{2}$ SOUTH FRONT-STREET, (DRAWBRIDGE.)

THE Subscriber grateful for past favours, informs his friends and the public that he has now on hand, an elegant and extensive assortment of ready made clothing, of every description, suitable for the season, which will be disposed of on the lowest terms for Cash.

Also a handsome selection of Cloths, Cassimeres, and Vestings, which will be made to order, in the most fashionable manner, and on the most reasonable terms.

Philadelphia, May, 1826

S. DEWEES

PORTER, ALE AND CIDER.

GILLIN & HILL.

RETURN their thanks to their customers for the liberal Patronage they have received, respectfully inform them and the public, that they still continue Bottling, at their old established stands,

No. 3 Pear-street, and 244 South Second-street,

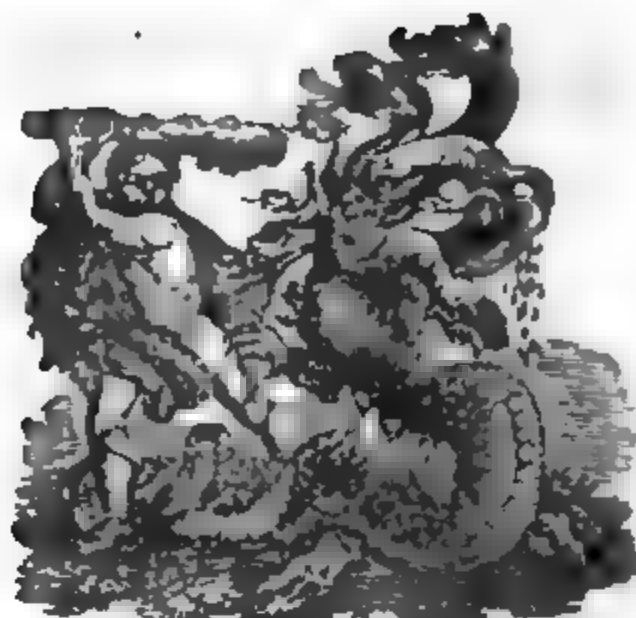
Where they have on hand, a quantity of Porter, Ale and Cider, in large Bottles of a superior quality, which they will sell on reasonable terms.

N. B. On hand, 300 Hogsheads of superfine CIDER, equal to any ever offered for sale in this City which will be sold by the Hogshead or Barrel, or put up for Exportation at the shortest notice

IF Merchants, Captains of vessels and others, can have their sea stores put up in the best order and at the shortest notice, by applying as above — Highest price given for empty bottles, or they will be received in exchange for Porter.

Philadelphia, May, 1826.

X x



SWAIN'S PANACEA.

THIS medicine is offered as a remedy for Scrofula or King's Evil, Ulcerated Sore Throat, long standing Rheumatic Affections, Cutaneous Diseases, White Swelling and Diseases of the Bones, and all cases generally of an ulcerous character, and chronic diseases arising in debilitated constitutions, but more especially for Syphilis, or affection arising therefrom, Ulcers of the Larynx, Nodes, &c. and that dreadful disease occasioned by a long and excessive use of mercury, &c. &c.—It has been found to be a most useful spring and autumn alterative for debilitated persons; it has also been found useful in Diseases of the Liver.

In all disorders arising from an impure or contaminated state of the Blood, it will be found a powerful and an effectual remedy. The discovery of this medicine has been the effect of long and attentive study, and it is now made public from the most decided conviction, founded on ample experience, of its power in eradicating those diseases, after every other medicine has failed.

It cannot, however, be supposed, that this PANACEA will invariably cure—the most esteemed medicines, employed by the Faculty, will often fail in the very diseases for which they are considered specifics, but if the use of it be persevered in, it will radically remove almost every case of the disorders specified. Thousands are lying under those complaints, in some form, sinking to the grave, without a remedy, when this medicine would certainly restore to perfect health and vigour. Its safety and innocence have been fully tested, so that it may be administered to the tenderest infant. The most distinguished physicians in the United States recommend it, and admit, that a more important discovery in medical science has not been made, and to use the language of one of the most eminent Professors of the age, *it is a triumph in the healing art.* To the present and rising generations the benefit must prove incalculable, not only by saving many valuable lives, but imparting strength and soundness to debilitated and corrupt constitutions,—*thereby preserving their offspring from hereditary diseases.* These facts, together with the numerous cures made, form *irresistible proof* of the high value of this remedy. No one, however, is advised to take it, without first fully convincing himself of the truth of what is here stated, and the rectitude of the Proprietor's intentions.

The cures performed in this city alone, establish its superior virtues on a basis too solid to be affected by the malignity of the envious. It is worthy of remark, that the greater part of the patients who have been permanently cured, had, previous to the Proprietor's undertaking them, received the ablest assistance, and several were abandoned by their Physicians, as being beyond the reach of human skill. Such is the fact, and so extraordinary were many of the cures, that an exhibition was made of them in the University of Pennsylvania, by the Professor of Surgery, before a crowded audience of Students, who pronounced them wonders in the healing art. It has been introduced into the PHILADELPHIA ALMS-HOUSE and PENNSYLVANIA and NEW-YORK HOSPITALS, and such were its surprising effects—its success after all other medicines had failed, that the Surgeon of the Pennsylvania Hospital, Dr. Wm. Price, was induced to abandon his highly respectable office, from the laudable design of benefiting his fellow creatures, by carrying the Panacea to England; where it has already superseded the use of the genuine French Rob of Lafacteur in a number of instances, in diseases for which that is intended, and its virtues are publicly acknowledged by some of the most eminent Surgeons there.

In all complicated cases of Scrofula and Syphilis, and where the Syphilitic Virus of the parent causes a development of Scrofula in the child, this is the only remedy upon

which a single hope of recovery can be reasonably founded; there has been no instance of its failure, where properly used. It imparts vigour to the whole system while the cure is going on—an operation so long looked for in vain by the medical world; at the same time the patient is enabled to take nourishing food, which under the common modes of practice, is usually withheld from the sufferer. In many instances where the horrible ravages of ulceration had laid bare ligament and bone, and where, to all appearance, no human means but amputation could have saved life, in cases extreme even as here described, have patients been snatched from the grave and restored to good health, and the devouring disease completely eradicated. The discovery of a remedy like this now offered for sale has been a desideratum from time immemorial.

CERTIFICATES.

"I have within the last two years had an opportunity of seeing several cases of very inveterate ulcers, which, having resisted previously the regular modes of treatment, were healed by the use of Mr. Swaim's *Panacea*; and I do believe, from what I have seen, that it will prove an important remedy in scrofulous, venereal, and mercurial diseases.

N. CHAPMAN, M. D.

Professor of the Institutes and Practice of Physic, and Clinical Practice, in the University of Pennsylvania, President of the Academy of Medicine of Philadelphia, &c. &c.
Philadelphia, February 16, 1823."

"I have employed the *Panacea* of Mr. Swaim, in numerous instances, within the last three years, and I have always found it extremely efficacious, especially in secondary syphilis and in mercurial disease. I have no hesitation in pronouncing it a medicine of inestimable value.

W. GIBSON, M. D.

Professor of Surgery in the University of Pennsylvania, Surgeon and Clinical Lecturer to the Alms-House Infirmary, &c. &c.
February 17, 1823."

"I have repeatedly used *Swaim's Panacea*, both in the Hospital and in private practice, and have found it to be a valuable medicine in chronic, syphilitic and scrofulous complaints, and in obstinate cutaneous affections.

VALENTINE MOTT, M. D.

Professor of Surgery in the University of New-York, Surgeon of the New-York Hospital, &c. &c.
New-York, 1st Mo. 5th, 1824."

"I have much pleasure in saying I witnessed the most decided and happy effects in several instances of inveterate diseases from Mr. Swaim's *Panacea*, where other remedies had failed—one was that of Mrs. Brown.*

WM. P. DEWEES, M. D.

Adjunct Professor of Midwifery in the University of Pennsylvania, &c. &c.
Philadelphia, February 20, 1823."

"I cheerfully add my testimony in favour of Mr. Swaim's *Panacea*, as a remedy in Scrofula. I saw two inveterate cases perfectly cured by it, after the usual remedies had been long tried without effect—those of Mrs. Offner* and Mrs. Campbell.*

JAMES MEASE, M. D.

Member of the American Philosophical Society, &c.

Philadelphia, February 19, 1823."

"Washington City, March 25th, 1824.

Sir,—With regard to your *Panacea*, I hesitate not to say, after a good deal of experience of its use in such diseases as you have announced it as a remedy for, that I think it a valuable acquisition to valetudinarians from those diseases, and that they may confidently expect from it benefits, which I believe cannot be derived from any other medicinal aid now known. Yours, &c.

THOMAS H. HALL, M. D.

Member of Congress from the State of North Carolina, &c.

Mr. Wm. Swaim, Philadelphia."

"At the request of W. Swaim, I hereby certify that in the few cases I have seen his *Panacea* given, I have observed great benefit derived from its use, and particularly in the case of R. C. Tregomaine,* who was for many years afflicted with very inveterate ulcers, that were deemed incurable by some eminent surgeons, who had attended her.—In this hopeless situation, she was (in September, 1821,) admitted a patient in the Pennsylvania Hospital, and had the advice of all the surgeons of that benevolent institution, without receiving much relief, when she began the use of the *Panacea*, which, to the surprise of all who witnessed its effects, restored her to good health, in a short time. In October, 1823, she was discharged from the Hospital, perfectly cured.

From observing the wonderful effects of Swaim's *Panacea* in R. C. Tregomaine's case, and from several well attested reports of many of our most eminent surgeons, I am

* See "A Treatise on Swaim's *Panacea*," for a history of the cases referred to.

induced to believe it is a very useful remedy in chronic, syphilitic, mercurial and scrofulous complaints.

THOMAS PARKE, M. D.

President of the College of Physicians, formerly Physician to the Pennsylvania Hospital, &c. &c.
Locust-street, Phila. 11th Mo. 1st, 1824."

"Having had frequent opportunities, of witnessing the effects of the article denominated *Swaim's Panacea*, I must candidly say, that I have been much pleased with the results of its success, particularly in the following diseases, viz. Scrofula, Syphilitic, and Mercurial diseases, Tumours, and Ulcers, where there has not only been great destruction of the soft parts, but also where caries of the bones have extended to a very considerable extent.

JOHN Y. CLARK, M. D.

Philadelphia, January 18th, 1825."

"Having witnessed the decided efficacy of the medicine called *Swaim's Panacea* in several cases of inveterate disease, that had resisted the usual remedies, justice requires that I should give my testimony in its favour. Among other cases that have come under my notice, those of Mrs. Hocker,* of Kensington, and J. Lambert's child,* are the most worthy of notice. In the former case, there was extensive ulceration and caries of the bones of the face, that was rapidly extending its ravages to the nose and palate. In the latter, a gangrenous ulceration, commencing on the inside of the cheek, had extended to the outside, and destroyed a portion of the cheek, and threatened its entire destruction. In both these cases, the diseases were in a progressive state, although very active treatment had been used, without benefit; but were speedily arrested in their progress, and in a short time perfectly cured by the use of Mr. Swaim's medicine.

ALEX. KNIGHT, M. D.

Port Physician of Philadelphia, &c.

Philadelphia, December, 1824."

"I have used Mr. Swaim's *Panacea* in several cases of secondary syphilis, which were sent to the Navy Hospital at Brooklyn, and feel pleased to say with complete success.

SAMUEL R. MARSHALL, M. D.

Surgeon of the United States' Naval Hospital, New-York, &c.

New-York, August 19, 1825."



AGENTS.

Boston—J. P. Hall, Druggist, No. 1 Union-Street. New-York—D. D. Smith, Bookseller, Greenwich-street, near Vesey-street, and Hull & Bowne, Druggists, Pearl-street, near Wall-street. Albany—Mancius & Vandenburg, Druggists. Portland, (Maine)—James Dorance. Newark, (N. J.)—Benjamin Olds, Bookseller. New Brunswick, (N. J.)—Terhune & Letson, Booksellers. Trenton, (N. J.)—Thomas L. Woodruff. Lancaster, (Pa.)—Henry Keffer. Pittsburgh, (Pa.)—Charles Avery & Co. Druggists. Harrisburgh, (Pa.)—N. Callender, Druggist. Cincinnati, (Ohio)—M. Wolfe & Co. Wilmington, (Del.)—Joseph Brinhurst, and M. Johnson. Baltimore—Henry Price, Druggist, Market-street. Washington City—William Gunton, Druggist. Alexandria—Edward Stabler & Son, Druggists. Richmond, (Va.)—James M'Kildoe, Druggist. Petersburg, (Va.)—Bragg & Jones, Druggists. Fredericksburgh, (Va.)—Dr. James Cooke. Lynchburgh, (Va.)—Walter H. Middleton, Druggist. Norfolk—Christopher Hall, Bookseller. Newbern, (N. C.)—Salmon Hall, Bookseller. Raleigh, (N. C.)—Webb & Williams. Washington, (N. C.)—John Gallagher, Postmaster. Tarborough, (N. C.)—Dr. Ward. Charleston, (S. C.)—S. Huard, Druggist, Broad-street. Savannah, (Geo.)—Anson Parsons, Druggist. Augusta, (Geo.)—William H. Turpin, Druggist. Natchez—Franklin Beaumont, Druggist. New Orleans—William M'Kee. Lexington, (Ky.)—H. & I. Ritchie, Druggists, Sole Agents for the State.—They will promptly attend to all orders for the *Panacea*.



CAUTION TO PURCHASERS.

The great demand and wonderful success of this medicine, have induced a number of persons to imitate it in various ways—Some are selling Sarsaparilla and other syrups, imposing them on the ignorant for the *Panacea*; others are mixing the genuine medicine with molasses, &c., making three bottles out of one; thus retaining some of its virtues. Those imitations and adulterations have, in many instances, protracted the sufferings of patients in cases where the genuine medicine would have proved instantly efficacious. I therefore deem it a duty I owe the public, to acquaint them, that it is impossible, from the very nature of its constituents, to be discovered by chymical analysis; and consequently, that all other mixtures represented to be mine and sold as such, are

* See "A Treatise on Swaim's *Panacea*," for a history of the cases referred to.

fraudulent and base impositions, calculated to deceive the ignorant and unwary.—The genuine medicine has my signature on a label representing *Hercules and the Hydra*, and my name on the seal.

Price Three Dollars per bottle, or Thirty Dollars per dozen.

Communications, post paid, and orders from any part of the world, will receive immediate attention.

Printed Directions accompany the Medicine.

WM. SWAIM,

No. 221 Chestnut street, near the Masonic Hall.

Philadelphia, May, 1926.

COMMUNICATION.

SWAIM'S PANACEA.

Having made the proper inquiry, we can vouch for the accuracy of the statement contained in the subjoined communication. No one should hesitate to bear just evidence to the merits of a medicine like that of Mr. Swaim, which would seem to be very different from the nostrums of the day.—*Ed. Nat. Gaz.*

To the Editor of the National Gazette

Dr. Gibson, professor of surgery in the University of Pennsylvania, in his lecture on Monday last, spoke in high terms of Mr. Swaim's Panacea. He remarked that he had found it decidedly beneficial in chronic cases of Syphilis, &c. and that he had known patients who had laboured under this disease for a length of time, and tried almost every remedy commonly employed for its cure with very little if any effect, but who, after using the Panacea, recovered quickly and entirely. He related several instances of rapid and extraordinary restoration to robust health, from a state of the most miserable weakness and infection wherein repeated salivations had produced only the mischief incident to the use of mercury. He spoke likewise of Mr. Swaim personally acknowledging the generosity which he had shown in the distribution of his medicine to the poor, and in the support, even of whole families, until a cure was effected.

The professor mentioned that he had been censured by surgeons and physicians for recommending the Panacea of Swaim, but that he thought it a duty which he owed to suffering humanity, not to withhold the expression of his opinion and experience of its efficacious character.

N. B. It is to be regretted that there are a number of spurious mixtures in imitation of this most valuable remedy, which have done much mischief, we are glad to find that no respectable druggist is concerned in the fraud.

Philadelphia, January, 1925

Medicus.

REDUCTION OF ONE HALF.

Philadelphia Silver Spoon and Fork Manufactory,

N. W. corner of Fifth and Cherry-streets.

The Subscribers, Wholesale Manufacturers of Silver Spoons, Forks, Ladles, &c. have now commenced *Retailing* all articles in their line, at a reduction of 50 per cent below the retail price of manufacturing. Table Spoons, for which the public have been paying from 12 to \$16 per dozen for manufacturing they now make for \$6. Tea Spoons, the store price of which is \$5 per dozen for making, they retail at \$2.50, above the cost of silver, and other work in proportion.

This will reduce heavy Spoons to about \$1.10, or \$1.45 per ounce. None can, nor shall undersell them. They are the only Manufacturers in this city, who have been brought up to this business exclusively. They have Manufactured for the principal stores in this place and elsewhere for many years, and assure the public that their work, both polished and burnished, shall be finished in a very superior manner, and always, for cash, at the wholesale prices, let them be what they may. The public are invited to call, and see the superior finish of the work, and judge for themselves. Their burnished work, marked "Standard," shall be Manufactured of Spanish Dollars, when they can be procured, but never under the standard of our country, polished work, marked "Crowns," shall be Manufactured of French Crowns. This is the finest silver manufactured in the United States, and to give the public a guarantee, they engage to pay \$100 to any person who will assay their work—marked, and prove it below its stamp, also to forfeit double the amount of work purchased. As there is no assay office in this place, they deem such a guarantee absolutely necessary, and in justice to the public, every one who sells Silver ought to come under some such regulation, as it is well known that it can be manufactured from 10 to 20 per cent worse than Standard, and none can tell the difference in appearance.

Philadelphia, May, 1926

R. & W. WILSON

ABRAHAM CARGILL'S
TIN WARE MANUFACTORY,
 AND
KITCHEN FURNITURE WAREHOUSE,
 232 WATER-STREET,
Third House East of Beekman-street,
 NEW-YORK,

Has constantly for sale a large assortment of *Tin Ware*. Also—Brass kettles, bell metal kettles, copper tea kettles, iron pots and kettles. pewter ware, iron and lead weights, tin and pewter liquor measures, scales and beams, block tin taps, wooden measures, composition tea kettles and sauce-pans, patent scale beams, &c. Together with a variety of house-keeping articles, all of good quality, and at fair prices.

May, 1826.



CLOTH HAT AND FUR CAP MANUFACTORY,
 No. 102 WILLIAM-STREET, NEW-YORK.

LUKE DAVIES,

Manufactures gentlemen's Cloth, Morocco, and Fur Travelling Caps ; children's Cloth and Morocco Caps and Hats, of different shapes and colours ; ladies' Seal, Gennet, and Chinchilli Caps. wholesale and retail :—Also, an assortment of Fancy Articles ; and many other articles, too numerous to mention—all of which will be sold low.

N. B. A constant supply of children's Morocco Hats, suitable for the Southern Market.

April, 1826.

GEORGE WILLIG,
 AT HIS
MUSICAL MAGAZINE,
 No. 171 CHESNUT-STREET,
 OFFERS FOR SALE,

Grand and Square German Pianos, superior quality, with Turkish music.

Grand and Square English Pianos, superior quality.

Elegant English and French Harps.

Flutes, Fifes, Clarionets, Guitars. Bassoons, French Horns, Trumpets and Flageolets.

Extra fine Violins, and low priced Violins, by the dozen.

Violin Bows ; Italian, French and German Violin Strings, Violin Basses, Harp and Guitar Strings, &c. &c.

G. W. receives regularly from England, France, and Germany, the newest Music, and is daily making additions to his own publications.

Country Merchants supplied with all kinds of Instruments and Music on liberal terms.

Military Bands supplied with warranted instruments.

Philadelphia, May, 1826.

ANTHONY DAVENPORT,
Mathematical and Nautical Instrument Maker,

At the sign of the Quadrant and Compass, No. 10 Jones'-Row, Exchange-street. Informs his friends and the public that he continues to carry on the above business exclusive from any other, and will pay his whole attention to the same, where ship owners, masters of vessels, and others, can be assured that their work will be done with correctness and despatch. Also keeps constantly on hand, Brass, Wood, and Cabin Compasses—Half hour and log Glasses, Quadrants, Spy Glasses, Scales, and Dividers, Thermometers. Parallel Rules—Gaaging Rods, with a variety of Surveyor's Instruments.

N. B. Grateful for past favours, and solicits a continuance of the same.

Portland, May, 1826.

FANCY AND WINDSOR CHAIRS.

JOSEPH BURDEN,

No. 97 South Third-street, nearly opposite the Mansion House.

PHILADELPHIA,

MANUFACTURES Fancy and Windsor Chairs, Lounges and Settees, and has also, constantly on hand, an extensive assortment of Cane, Rush, and Common Chairs as knock-downs, suitable for exportation

SPLIT RATTAN,

for Chair, Coach, and Cabinet Makers, as also Copal Varnish of the first quality, for sale.

May, 1826.

COPPER-WARE MANUFACTORY AND STORE.



FRANCIS HARLEY,

No. 78 South Front-street, (West side.)

PHILADELPHIA,

HAS constantly on hand, of his own Manufacturing, Stills, with Patent (Pewter Worms, calculated for the West India Market. Kettles for Manufacturers. Varnish and Glue Kettles. Sauce Pans and Coal Scuttles. Ship Chandlers furnished with every article in their line. Stills for Fruit, Grain, and Turpentine Distillation. Hatters' Plank and Colouring Kettles. Copper and Brass Wash and Preserving Kettles. Ships' Water Casks, and Tank Pumps. Grocers' Pumps and Measures. Sugar Refiners' Boilers, Ladles, &c. Tallow Chandlers' Boilers Ladles, &c. Gun Ladles, Powder Measures and Magazines.

ALSO,—For Sale. An assortment of Sheathing Copper, Nails for Coppering, Wood Spikes for Boat Building, and Pump Boxes. Bells for Churches, Ships, Plantations, &c. Black Lead in Pigs and Bars. Spelter and Borax. Black Lead Crucibles.

Orders thankfully received and punctually attended to — All the above Repaired.

N. B. Old Copper, Brass and Lead, bought or taken in payment.

May, 1826.

EDWARD COOK,

No. 6, BOWERY,—NEW-YORK,

HAS constantly on hand, a full and complete assortment of China, Glass and Earthenware, of his own importation, which he will sell on the most reasonable terms, wholesale and retail.

N. B. Country orders put up, and Ships fitted out on the shortest notice, cheap for Cash.

May, 1826.

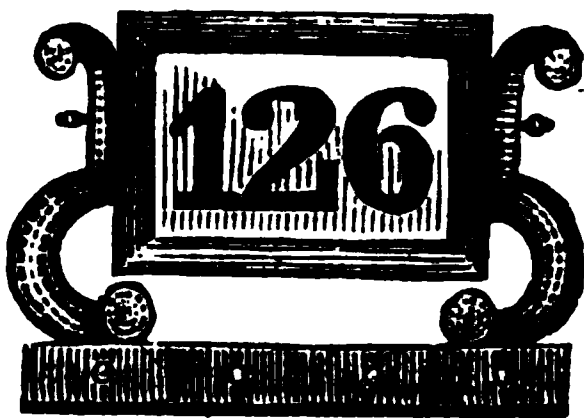
SHIPS' MEDICINE CHESTS.

Fifty Medicine Chests for vessels of 100 to 600 tons, put up in the best and most economical manner, by M. S. LITTLE, No. 29 Bowery, (near Chatham-st.) corner Bayard-street who has constantly on hand Drugs and Medicines, Dye Woods and Dye Stuffs, Paints, Glass Oil, &c.

Saratoga and Ballston Water put up in boxes of 1 to 4 dozen each

April, 1826.

FASHIONABLE FURNITURE.



ANTHONY G. QUERVILLE,

No. 126 South Second-street, (a few doors below the Custom House,)

RESPECTFULLY informs the public that he has so enlarged his Manufactory as to enable him to keep constantly on hand an extensive supply of CABINETWARE, such as

Elegant Fashionable SIDEBARDS, various patterns. BUREAUS, various fashions. SOFAS, very elegant. DRESSING TABLES, of all descriptions. WASH STANDS, closed and open. TABLES, Breakfast, Dining and Card. BEDSTEADS, Mahogany, Maple and Cherry, of all sizes.

Shipping Merchants and others, will find it greatly to their interest to give him a call before purchasing elsewhere, as he is determined to sell at the most reasonable prices; and his furniture being manufactured immediately under his own direction, will be warranted equal both in material and workmanship to any made in this country.

Philadelphia, May, 1826.

JOHN LEADBEATER, PATENT LAMP MANUFACTORY,

No. 93 Walnut-street,—PHILADELPHIA.

May, 1826.

FASHIONABLE CLOTHING WAREHOUSE,

*S. W. corner of Second and Chesnut-streets,
PHILADELPHIA.*

SILVEIRA & BROWNE respectfully inform their friends and the public generally, that they have on hand a large and extensive assortment of ready made Garments of every description, among which are the following :—

Black and blue dress coats. Olive and brown do. do. Olive, brown and blue frock coats. Drab, newmarket and box do. Olive and mixed double breasted surtouts. Black and white dress vests. Fancy toillet and valenciado. Black and white cammere dress pantaloons. Milled, drab and mixed dress pantaloons. Blue, white and pink under vests. Super blue camblet and tartan plaid cloaks. Patent suspenders. Fine flannel long and short drawers. Superfine linen shirts, ruffled and plain. Do. white, corded and plain muslin cravats. Do. fancy, do. Superfine black silk handkerchiefs large sizes. English white and black silk half hose. White and coloured Woodstock gloves. Black and white hoskin do. Black English silk stocks. English and German silk pocket handkerchiefs.

* * * All the above articles will be disposed of for cash on the most moderate terms by the single garment or quantity, to suit purchasers.

††† Embroidery and ornamental needlework of all descriptions handsomely executed.

N. B. Any number of Garments made at 10 hours' notice.

May, 1826.

HOFFMAN & ROACH, WHOLESALE AND RETAIL GROCERS,

No. 114 Canal-street, corner of Lawrence,

Keep constantly on hand a complete assortment of GROCERIES of the best quality, for Family and Ship use.

☞ Sent to any part of the city, free of expense.

New-York, 1826.

CLARKSON CROLIUS & SON

HAVE ON HAND, AT THEIR

MANUFACTORIES,

No. 8 Cross, & 67 Bayard-streets,

NEW-YORK,

A GENERAL ASSORTMENT OF

STONE-WARE,

OF THE BEST QUALITY,

WHICH they offer for sale by the crate or dozen, at fair prices, and on reasonable terms.

. Articles of every description made to order.

[] Orders put up at the shortest notice, and in the best manner.

July, 1826.

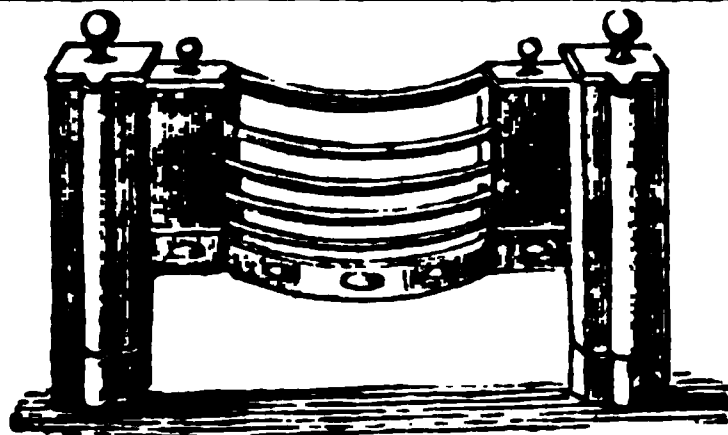
WM. PLYMPTON,

No. 7 WALL-STREET, NEW-YORK,

COMMISSION WINE MERCHANT.

PROPRIETORS of Hotels, and MASTERS of Vessels may at all times have their orders supplied with WINES and SPIRITS of the first quality, and being near the Custom House, it will be very convenient to call and examine for themselves.

July, 1826.



JAMES KELLY,

GRATE & FENDER MAKER,

S.MOKE-JACK & LOCKSMITH,

NO. 20 NASSAU-STREET,

NEW-YORK.

GRATES and FENDERS Wholesale and Retail. (The store lately occupied by G. Thorburn & Son, Seedsman and Florists.)

July, 1826.

FOR SALE

BY

ZINA HYDE,

AT HIS STORE IN BATH, (MAINE.)

A constant supply of NAUTICAL BOOKS, CHARTS, and INSTRUMENTS, together with an extensive assortment of SHIP CHANDLERY, HARDWARE GOODS, PAINTS, and NAVAL STORES.

June, 1826.

JOHN GRAHAM,

Cabinet, Chair, and Sofa Manufacturer,

NO. 94 SOUTH THIRD STREET,

(Nearly opposite St. Paul's Church.)

PHILADELPHIA.

June, 1826.

AARON H. PALMER'S
STOCK EXCHANGE, AGENCY AND LOAN OFFICE,
 33 WALL-STREET, NEW-YORK, (UP STAIRS.)

IN this establishment, Public Securities of the Government of the United States, Stocks, &c. are bought and sold exclusively on commission; Bills of Exchange on London, Paris, Amsterdam, and Hamburgh, negotiated—Bills, Notes and Drafts collected, and Debts, Claims, Inheritances, &c. recovered in the principal cities and towns in the United States and Canada; Money taken on deposits, at interest, secured by a transfer of Public Securities or Stock; Loans and Advances made on collateral assignment of stocks, and on Bond and Mortgage of unincumbered Real Estate. The highest premium given for Doubloons, Sovereigns, all other foreign Gold, R. Union, and Bank of England Notes.

July, 1826.

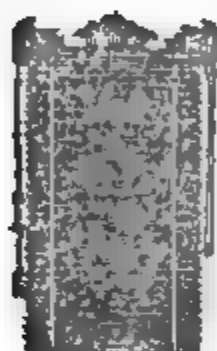
OFICINA DE CAMBIO,

*Préstamo, Negociación de fondos Públicos y Agencia General,
 en Nueva-York, No. 33 Wall-street, Cuarto Principal.*

EN este establecimiento se compran y venden (exclusivamente en Comision,) las acciones de fondos públicos del gobierno de los Estados Unidos en general. Se negocian Letras de Cambio sobre Londres, Paris, Amsterdam, Hamburgo, &c.; y se procura y agencia el cobro de libranzas, deudas, reclamaciones, herencias, cuentas, &c. Se recibe dinero en depósito con causa de rédito; y tambien se presta bajo las seguridades correspondientes. Se paga un buen premio por los *Dobloones, Sovereigns, Onzas*, y toda especie de oro en pasta ó acunada; y plata en barras ó pesos fuertes; y se cambian *Billetes del Banco de Inglaterra* por.

AARON H. PALMER.

July, 1826.



BLIND FACTORY.

*Wholesale and Retail, by James Bolen, 350
 Broadway, corner of Leonard-street.*

EVERY description for sale on hand or manufactured at order, including those for Windows, Doors, Screens, &c. &c. on moderate condition terms. Communications received from a distance immediately complied with. Merchants and Ship-Masters will



find every accommodation and facility in the execution of order.

July, 1826.



HAT MANUFACTORY.

100 Delancey-street, New-York.

WELLS & REDFIELD, Hat Manufacturers, No. 100 Delancey-street, New-York have constantly for sale, manufactured under their personal direction, and from the best materials, a very general assortment of Beaver and imitation Beaver HATS, where wholesale orders will be immediately supplied.

Southern Merchants whose object is to purchase where a general assortment and liberal terms may be found, will find it for their interest to apply as above.

July, 1826

JOHN I. RICKER,
IMPORTER AND MANUFACTURER,
OF PIANO FORTES, &c.

And Music Seller, No. 187 Broadway, New-York.

Also constantly on hand, an extensive assortment of Flutes, Clarionets, Drums, Fifes, Horns, Bugles, with every article belonging to his line of business.—June, 1826.



CHARLES FREDERICKS,

Manufacturer of Curled Maple, Rose Wood, Mahogany Chairs, and Cabinet Ware, wholesale and retail, No. 79 Broad-street.

New-York, July, 1826.

E. RILEY,
FACTEUR D'INSTRUMENS DE MUSIQUE,
NO. 29 RUE DE CHATHAM, NEW-YORK.

Des tambours de cuire, (avec des cottes d'armes selon l'ordre) un article d'objets particulièrement adopté dans les pays chauds, où les tambours colles ou cloués ne durent pas.

Instrument de Musique réparés et accordés de la meilleure manière

E. RILEY,
FABRICANTE DE INSTRUMENTOS
MUSICOS.

EN LA CALLE DE CHATHAM, NO. 29 NUEVA-YORKE.

Tiene tambores de bronce (con escudo de armas segun se ordene) un artículo propio para los climas calidos, donde no duran los clavados ó pegados con cola.

Se tiemplan y componen perfectamente de clase de instrumentos

Franklin Lottery and Exchange Office,
No. 20 SOUTH THIRD-STREET, PHILADELPHIA.

VANNEST & MONELL,

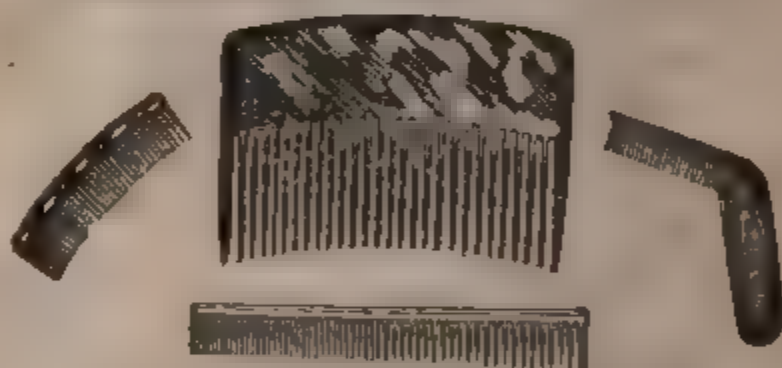
GRATEFUL for favours which they have heretofore received, inform their patrons and the public that they are still ready and willing to dispose of all the good chances which they may at any time have on hand, in the Lotteries about to be drawn, and that it is their determination to select such tickets and shares as will afford the most reasonable expectation of good luck.

V. & M. will also transact all kinds of Exchange business, at the above establishment upon the most favourable and reasonable terms.

N. B. Most uncurrent notes will be received at par for Tickets.

Philadelphia, May, 1826.

COMB AND FANCY STORE,



G. BUSHNELL,

No. 593 Broadway, nearly opposite Washington Hall,
NEW-YORK.

Has constantly for sale, wholesale and retail, a very complete assortment of COMBS and FANCY ARTICLES, suitable for toilets, where persons of taste and fashion may always furnish themselves.

N. B. Cash given for TORTOISE SHELL.

May, 1826.

WALTON HOUSE,

KEPT BY

SIMON BACKUS,

NO. 328 PEARL-STREET, (FRANKLIN SQUARE.)
NEW-YORK.

May, 1826.

House, Sign & Ornamental Painting,
GILDING AND GLAZING, BY

ROE & ELMENDORF.

Corner of North-Moore and Chapel-streets,
NEW-YORK.

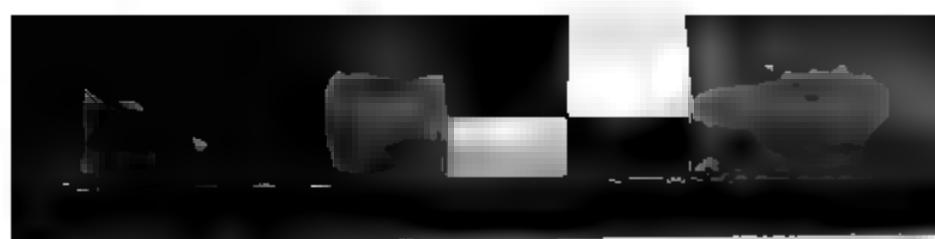
N. B. Paints, Oil Glass, &c. of the best quality.

June, 1826.

LIST OF
MAPS, CHARTS, & GEOGRAPHICAL WORKS
 RECENTLY PUBLISHED, AND FOR SALE BY
H. S. TANNER,
 GEOGRAPHER AND MAP PUBLISHER,
No. 177 Chesnut-street, PHILADELPHIA,

Where most other Publications, connected with American Geography, &c. may be had

- | | | |
|--|---|---------|
| No. 1. | A new American Atlas, containing Maps of the several States of the North American Union, projected and drawn on a uniform scale of fifteen miles to the inch, from documents found in the public offices of the United States, and state governments: to which are added, Maps of the World and Quarters; one of North America on four sheets, and one of South America on two sheets, together with Geographical Memoir, giving a detailed account of the materials used in the construction of the various Maps. The whole exhibiting a full and complete geographical view of the two continents of North and South America, in connexion with the other parts of the known world. This work has already passed through two editions, within the period of two years, and has received the approbation and patronage of many of the most distinguished, scientific, and literary characters both in this country and in Europe; special resolutions of Congress and other public bodies in its favour have been passed, and as the author is constantly engaged in the improvements of the plates, by inserting all new information, he trusts that it will continue to be what it has been since its publication, the standard as an American Atlas. Price of the work in half binding, | \$35 00 |
| No. 2. | The same, with the Maps mounted on rollers and varnished, | 40 00 |
| No. 3. | The same omitting the Maps of the World and Quarters, and reserving all those relating to North and South America, the States, &c. Price in half binding, | 25 00 |
| No. 4. | The same as the preceding, omitting the Map of South America, and the Geographical Memoir, and reserving all the Maps relating to the continent of North America, including the State Maps. Price, | 24 00 |
| No. 5. | Atlas of the United States, comprehended in eleven large sheet maps, drawn on a uniform scale of fifteen geographical miles to the inch. Price half bound, | 17 50 |
| No. 6. | The same pasted on pasteboards, bound and varnished, suitable for the use of schools. Price, | 20 00 |
| No. 7. | A new General Atlas, consisting of imperial sheet Maps of the World on the Globular projection, 2 sheets; World on Mercator projection, Europe, Asia, Africa, America, North America, South America, two sheets; United States and British possessions. Price half bound, | 8 00 |
| No. 8. | A new College Atlas, consisting of a series of General Maps of the various grand divisions of the known world, adapted to the course of geographical instruction, pursued in the colleges and high schools of the United States, imperial folio. Price. half bound, | 5 00 |
| No. 9. | The same as the preceding, with the Maps pasted on thick paste board and varnished, for the use of schools. Price, | 7 50 |
| No. 10. | Atlas of Ancient Geography, designed to illustrate the works of the ancient writers, both sacred and profane, sixteen select Maps in imperial quarto. Price half bound, | 2 50 |
| No. 11. | A new Map of North America on four sheets, embracing all the recent discoveries of Ross, Parry, Franklin, Long, &c. &c. Price, mounted on rollers, or in a portable form, | 8 00 |
| No. 12. | Arrowsmith's 4 sheet Map of Europe, improved to 1826. Price, | 8 00 |
| No. 13. | Do. do. Asia, do. do. do. | 3 00 |
| No. 14. | Do. do. Africa, do. do. do. | 8 00 |
| No. 15. | A new Map of South America, in 2 sheets, do. do. | 4 00 |
| The Maps numbered 11, 12, 13, 14, and 15, are usually sold together; they form a set on which is delineated the entire surface of the earth, and present as complete a body of geographical information on the known world, as the existing state of knowledge will admit. Price of the set, mounted on rollers and varnished, | | 33 00 |



- No. 16. Map of the World on the Globular projection, 2 sheets. This Map, although designed for the library and counting house, will be found highly useful in schools for which it is well adapted; its grand divisions are distinctly marked, and the various governments readily distinguished. Price on rollers and varnished, \$3 50
- No. 17. A new Map of the United States of Mexico, on one imperial sheet, drawn from the latest and best authorities, and exhibiting their subdivisions as they now exist; with numerous tables, &c. Price in pocket case. 2 00
- No. 18. Map of the Roads, Canals, and Steam Boat routes of the United States with the distances from place to place, and a series of tables showing the principal Steam Boat routes throughout the country. Price in pocket cases, 1 00
- No. 19. Map of the existing and contemplated canals of the state of Pennsylvania, coloured so as to distinguish between such as are finished or in progress, and those merely proposed. Price, 1 50
- No. 20. Map of the New England states, for travellers, in pocket case, 1 50
- No. 21. Map of the state of New-York, do. do. 1 50
- No. 22. Map of the states of Pennsylvania and New-Jersey, for travellers, in pocket case, 1 50
- No. 23. Map of the states of Ohio and Indiana, do. 1 50
- No. 24. Map of the states of Virginia, Maryland and Delaware, do. 1 50
- No. 25. Map of the states of Kentucky and Tennessee, do. 1 50
- No. 26. Map of the states of North and South Carolina, do. 1 50
- No. 27. Map of the states of Georgia and Alabama, do. 1 50
- No. 28. Map of the states of Louisiana and Mississippi, do. 1 50
- No. 29. Map of the states of Illinois and Missouri, do. 1 50
- No. 30. Map of the territory of Florida, do. 2 00

The State Maps numbered from 20 to 30 inclusive, are from the American Atlas, projected and drawn on a uniform scale of fifteen miles to the inch; they embrace in addition to former surveys, those made by order of the United States government; copies of these surveys, as they progress, are regularly forwarded to the author, by whom they are immediately inserted on the plates. By these means, and the facilities of procuring other information, afforded by an extensive correspondence, the maps are made to keep pace with the improvement of the country, and to exhibit at all times, the existing state of geographical information regarding the United States, and contiguous countries. The set, consisting of eleven Maps, printed on silk paper, is put up in a portable case for the convenience of travellers. Price, 15 00

The same Maps are put up separately on muslin, in a portable case. Price, each, 2 00

- No. 31. Chart of the World on Mercator's projection, 1 large sheet, 1 00
- No. 32. Map of Europe, 1 large sheet, 1 00
- No. 33. Map of Asia, do. 1 00
- No. 34. Map of Africa, do. 1 00
- No. 35. Map of America, do. 1 00
- No. 36. The four preceding Maps pasted together on one sheet of canvas, and roller, suitable for schools. Price, 5 50
- No. 37. Map of North America, one large sheet, 1 00
- No. 38. Map of the United States, medium sheet, 0 65
- No. 39. Map of New-Brunswick, Nova Scotia, Newfoundland, &c. 1 00
- No. 40. Chart of Delaware Bay, 2 sheets, 1 00
- No. 41. Dissected Map of the World, one large sheet, 2 50
- No. 42. Do. Europe, do. 2 50
- No. 43. Do. Asia, do. 2 50
- No. 44. Do. Africa, do. 2 50
- No. 45. Do. United States, do. 2 00
- No. 46. The Mariner's Atmospherical Register or Weather Book, 2 50
- No. 47. A general outline of the United States, with plates, 2 50
- No. 48. Atlas of outline Maps of the World, and Quarters, the set, 50
- No. 49. School Atlas, consisting of the World, Quarters, and United States, 50

A liberal deduction from the above prices will be made to colleges and schools.

* In preparation, a four sheet Map of the World, and a four sheet Map of the United States, on a scale of 30 miles to the inch. Also, Wilkinson's Atlas Classica, consisting of 57 Maps of Ancient Geography, in imperial quarto.

July, 1826

TICKETS & SHARES

For sale at the **SCHEME PRICE** until **SATURDAY** evening,
8th July, at the **"GOLD MINE," FORTUNE'S**
HOME, P. CANFIELD'S Office, 142 Broadway.

By Authority of the State of Maryland.
UNIVERSITY LOTTERY,
Ninth Class, New Series.

P. CANFIELD, Manager.

\$20,000 Highest Prize.

Scheme.

1	Prize of	\$20,000	is	\$20,000
1	::	10,000	::	10,000
1	::	5,000	::	5,000
1	::	2,500	::	2,500
1	::	1,308	::	1,308
5	::	1,000	::	5,000
10	::	500	::	5,000
44	::	100	::	4,400
88	::	50	::	4,400
528	::	12	::	6,336
5,676	::	6	::	34,056
<hr/>				
6,356	Prizes, {	19,600	}	\$98,000
13,244	Blanks, {	Tickets.		

The tickets in this Lottery are formed by the ternary combination of 50 numbers, from 1 to 50 inclusive; and to determine the fate of all the tickets therein, 50 numbers, as above, will severally be put into a wheel on the day of drawing, and 6 of them will be drawn; and that ticket having on it as a combination, the 1st, 2d, and 3d numbers drawn, will be entitled to the Capital Prize of.....\$20,000

That having on it the 4th, 5th, and 6th, will be entitled to a Prize of10,000

That having on it the 2d, 3d, and 4th, will be entitled to a Prize of5,000

That having on it the 1st, 3d, and 5th, will be entitled to a Prize of2,500

That having on it the 2d, 5th, and 6th, will be entitled to a Prize of1,308

Those having on them the 1st, 2d, and 4th,—1st, 2d, and 5th,—1st, 4th, and 5th, 2d, 3d, and 6th, and the 3d, 4th, and 6th, will each be entitled to a Prize of....1,000

Those having on them the 1st, 2d, and 6th,—1st, 3d, and 4th,—1st, 3d, and 6th,—1st, 4th, and 6th,—1st, 5th, and 6th,—2d, 3d, and 5th,—2d, 4th, and 5th,—2d, 4th, and 6th,—3d, 4th, and 5th,—and 3d, 5th, and 6th, will each be entitled to a Prize of.....500

Those having on them the 1st and 2d numbers drawn, will each be entitled to a Prize of.....100

Those having on them the 3d and 4th, and the 5th and 6th numbers drawn, will each be entitled to a prize of.....50

All others having on them any two of the drawn numbers, will each be entitled to a prize of12

And all others having on them one of the drawn numbers, will each be entitled to a prize of.....6

No ticket which shall have drawn a Prize of a superior denomination can be entitled to an inferior Prize.

A considerable portion of this Lottery is put up in Packages of 17 Tickets, each of which is warranted to draw \$36, less the 15 per cent. deducted by the State, with so many chances for the Capital Prizes.

This Lottery will positively take place in the city of Baltimore, on the 18th day of August, or sooner.

Prizes payable forty days after the drawing, and subject, as usual, to a deduction of fifteen per cent.

Tickets and Shares will be sold at the scheme price, viz. \$5 each, until Saturday, the 8th of July inclusive, at either of the Manager's Offices, 142 Broadway, New-York, 129 Chesnut-street, Philadelphia, and at 180 Market-street, Baltimore, for Cash, current at any of the banks in the cities of New-York, Philadelphia, or Balti-

more. Prize tickets will be received from vendors, at par, in payment. After the 8th of July, the price of Tickets will be advanced to \$6 each—Shares in proportion. Tickets and Shares, or Certificates in the above, may be ordered from the Office of the Subscriber, No. 129 Chestnut-street, Philadelphia as well as from Baltimore, and remittances for the same may be made to either of the Subscriber's Offices, as may be most convenient to those who shall send for tickets in the above Lottery.

The Cash will be advanced for Prizes in the above at any time after the drawing, at 142 Broadway, New-York, 129 Chestnut-street, Philadelphia, and at No. 180 Market, near Charles-street, Baltimore.

Orders (post paid) enclosing the Cash for one ticket, or more, will be thankfully received, and punctually attended to, if addressed to P. CANFIELD, New-York, Philadelphia, or Baltimore.

P. C. constantly keeps tickets in all the Lotteries for the accommodation of his friends and the public.

June, 1826



FASHIONABLE HAT STORES.

E. BLOOMER,

HAT MANUFACTURER,

No. 156 Broadway, New-York,

HAS constantly for sale a very general assortment of fashionable HATS, on the most reasonable terms.

E. BLOOMER has also, at his Store, No. 194 Canal-street, New-York, a handsome and fashionable assortment of the various qualities of Men's, Youths' and Boys' HATS, to which he respectfully invites public attention: wholesale purchasers will especially be pleased to observe that they will find an advantage in examining the samples there exhibited.

All the Goods on sale shall be manufactured by himself, and he is well aware that he consults his own interest most effectually by furnishing those articles alone which will afford satisfaction to his Customers.

ELISHA BLOOMER.

July, 1826.

"JUDD'S HOTEL,"

REVIVED, IMPROVED, AND ENLARGED.

THE Subscriber, with unusual solicitude to gratify and accommodate Travellers, the Public generally, and visitors to the United States from Europe and elsewhere, respectfully announces that he has rendered more commodious than ever that central and extensive Establishment, so long and universally known and frequented, under the appellation of JUDD'S HOTEL 27 South Third-street, between Market and Chestnut, Philadelphia—where, in the vicinity of the Banks, Coffee House, Custom House, and hum and bustle of active and fashionable life, Gentlemen of business or pleasure will ever find themselves at home, and from the numerous retired and private apartments, families travelling will always be certain of a desirable resting place.

Similar establishments throughout the United States have been lately eulogised, by citizens and foreigners, as possessing increased comforts and conveniences, and the present Proprietor of Judd's Hotel while soliciting public favour and patronage, requests permission to express his assurance that it shall be equal to any—superior to many—inferior to none—as his assistants and servants, equally with himself, will be studious to please, and always anxious to anticipate the wants and wishes, of his friends and supporters. The abundant luxuries and delicacies of the season shall be as abundantly supplied, and the best market in the world yield its best and most nutritious variety to gratify the taste and palates of his Visitors and Boarders.

The usual beverages shall be of the first quality, and foreign Wines and Liquors, as imported, shall be purchased by himself only, and furnished at his table in their purest state.

A personal inspection of the careful performance of his hostler's duties shall be considered all important, and, in a word, he pledges himself to those who may honour him with their company, that every thing tending to their comfort and convenience, that can be done shall be done. D. SAINT

June 1826

MARBLE WORKS.

DIXON & OATWELL,

INFORM their friends and the public, that they continue the Marble Business, in all its branches, at the corner of Varick and Canal-streets, New-York.

N. B. Engraving on Marble at the shortest notice. Foreign Marble purchased.
May, 1826.



LA FAYETTE

ELASTIC WATER PROOF
HAT MANUFACTORY.

S. C. KEYSER

Respectfully informs his friends, and the public in general, that he has commenced the above business in all its various branches, at No. 24 South Third-street, opposite JUDG'S HOTEL, where he hopes to meet with a share of public patronage.
Philadelphia, Sept. 1, 1826.

TRYON & CHASE,

MANUFACTURERS OF

Looking Glasses, Combs, Suspenders, and

IMPORTERS OF JAPANESE WARE,

*No. 54, Market-street, a few doors West of Second-street,
(South side,) Philadelphia,*

HAVE constantly on hand a very extensive assortment of Looking Glasses, viz—Mantle, Pier and Moulding Mahogany; Moulding and Pillar Pied Pillar and Fluted Toilets, and wings and covers, and in fact every description. Statia and German Toilets, Turtle Shell tucking, long, bent, neck, and side Combs, Mock Shell tucking, long, bent, neck, and side pocket heading dressing and ivory combs, also cotton and silk suspenders of all descriptions. Also, Japaned trays and waiters, of all colours, with and without centres, of the most superb patterns—and a great variety of other goods in the Fancy line, all of which are warranted to be excelled by none in the United States, in point of workmanship, sold together with the above on the most reasonable terms for cash or approved paper.

N. B. All orders attended to with the greatest punctuality, and packed in such a manner as to insure their safety, which is a very important matter to those dealing largely in Looking Glasses. From the advantage this establishment has above any other in the Union, they can sell lower in consequence, than any other.

May, 1826.

HEALTH BITTERS.

Prepared by a PHYSICIAN.

AND sold, wholesale and retail, at the corner of North-Moore and Varick-streets, and can be had at 293 and 284 Front-street, and at 37 and 13 South-street.

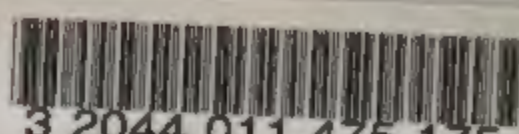
N. B. Said Bitters have been well attested, and have not failed to prevent bile on the stomach, brace, promote appetite, &c

DIRECTIONS FOR USING.

Take one or two teaspoonfuls at a time, in Wine, Cordial, or any kind of Spirits, three times a day, fasting.

P. S. To use said bitters is all the recommendation they require.
July, 1826.





3 2044 011 475 175

THE BORROWER WILL BE CHARGED
AN OVERDUE FEE IF THIS BOOK IS
NOT RETURNED TO THE LIBRARY ON
OR BEFORE THE LAST DATE STAMPED
BELOW. NON-RECEIPT OF OVERDUE
NOTICES DOES NOT EXEMPT THE
BORROWER FROM OVERDUE FEES.

Harvard College Widener Library
Cambridge, MA 02138 (617) 495-2413

